ASTRONOMY

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Backtracking the Comets

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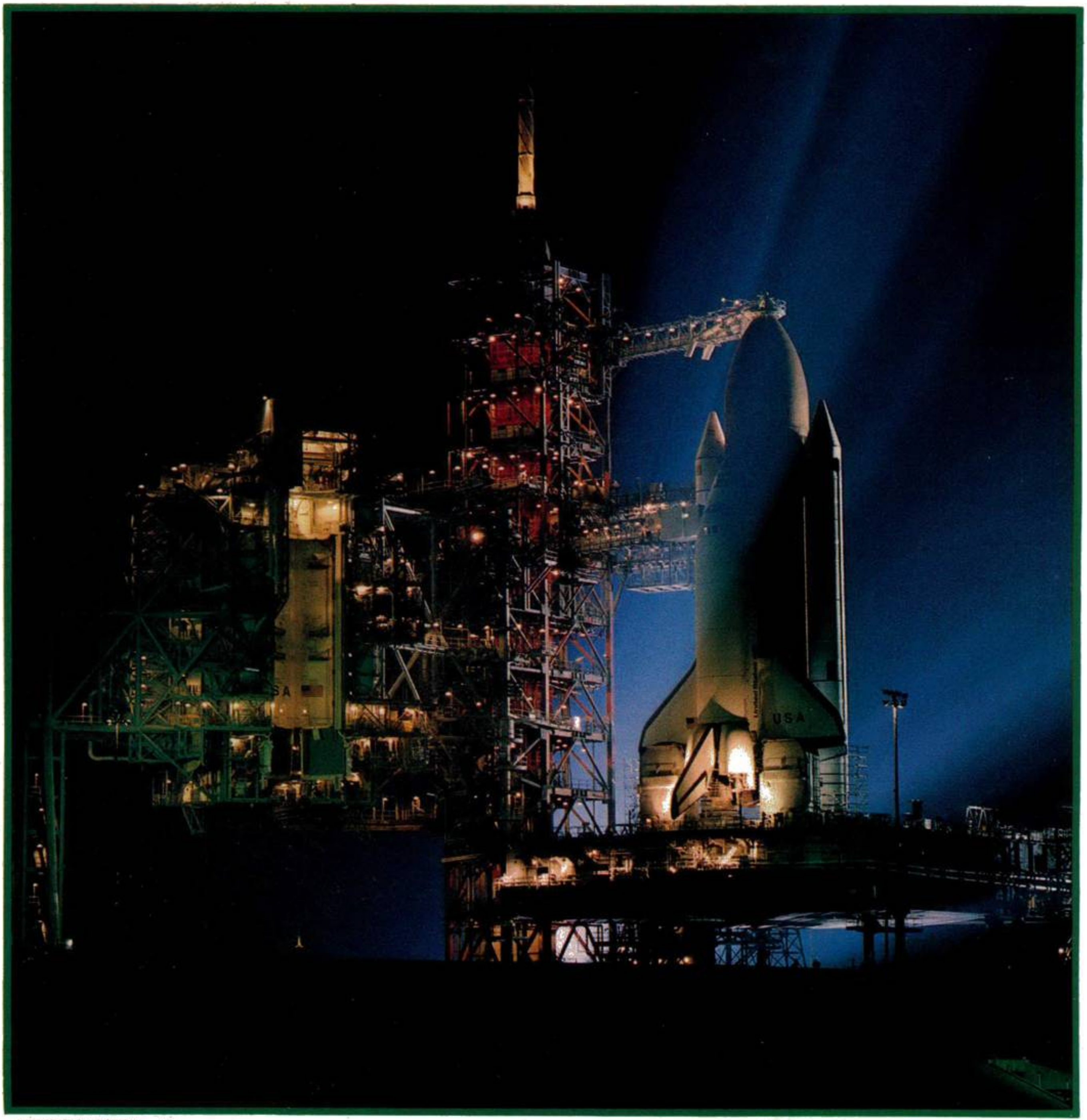

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Telescopes Shown: *(top) Meade 8″ Model 2080 with optional photographic systems, including 4″ Schmidt-Cassegrain Photo-Guide Telescope; and (bottom) Meade 10″ Model 2120 with optional 2″ f/12 Photo-Guide Telescope.*

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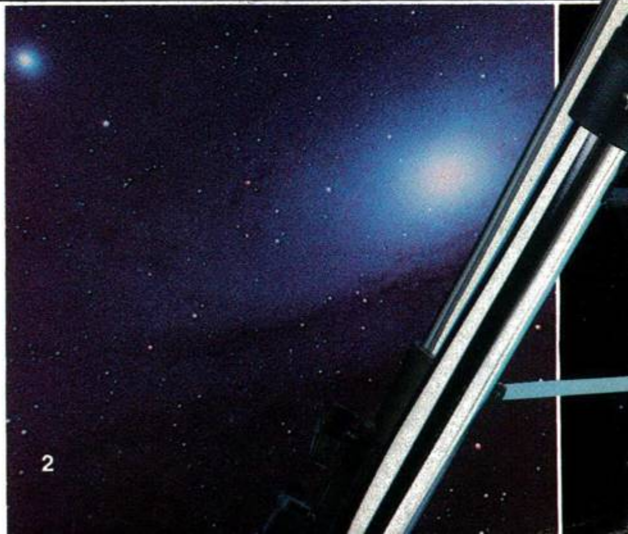

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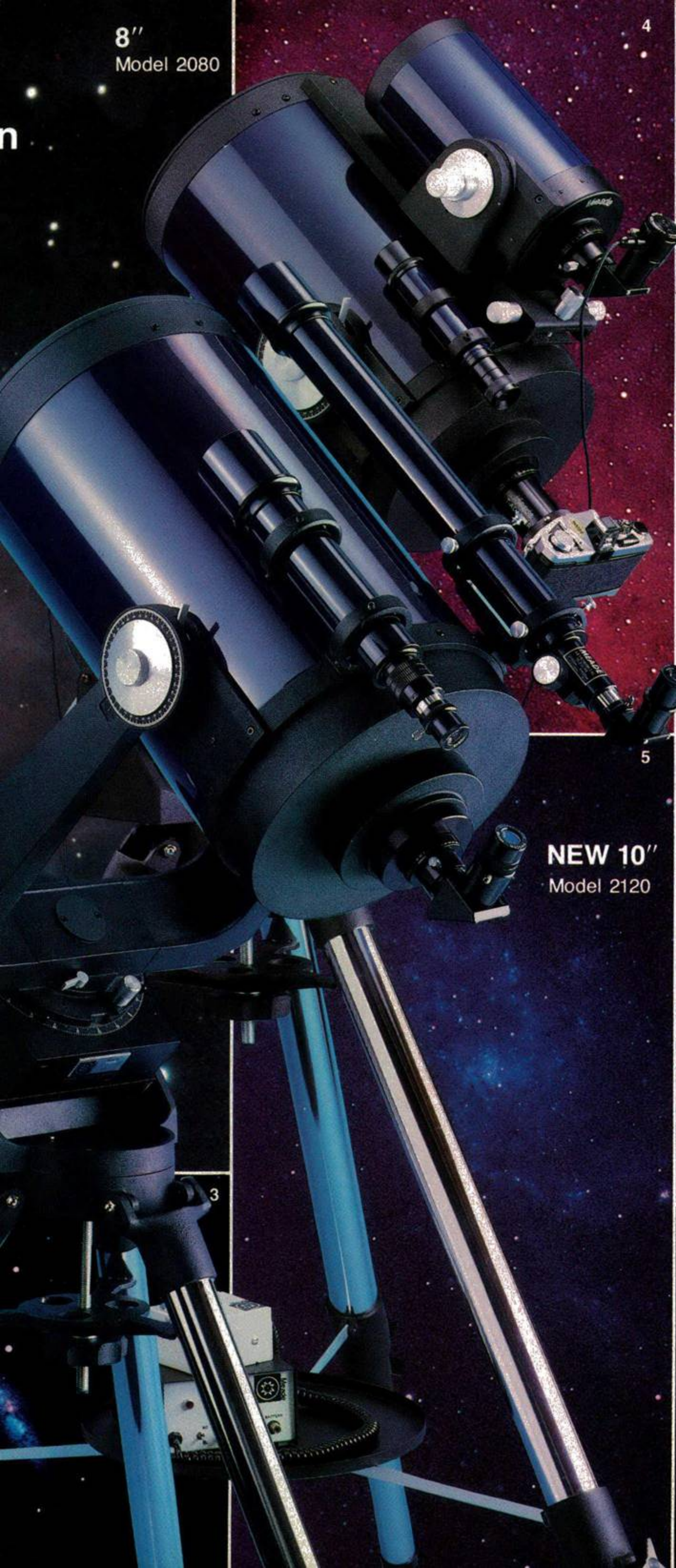
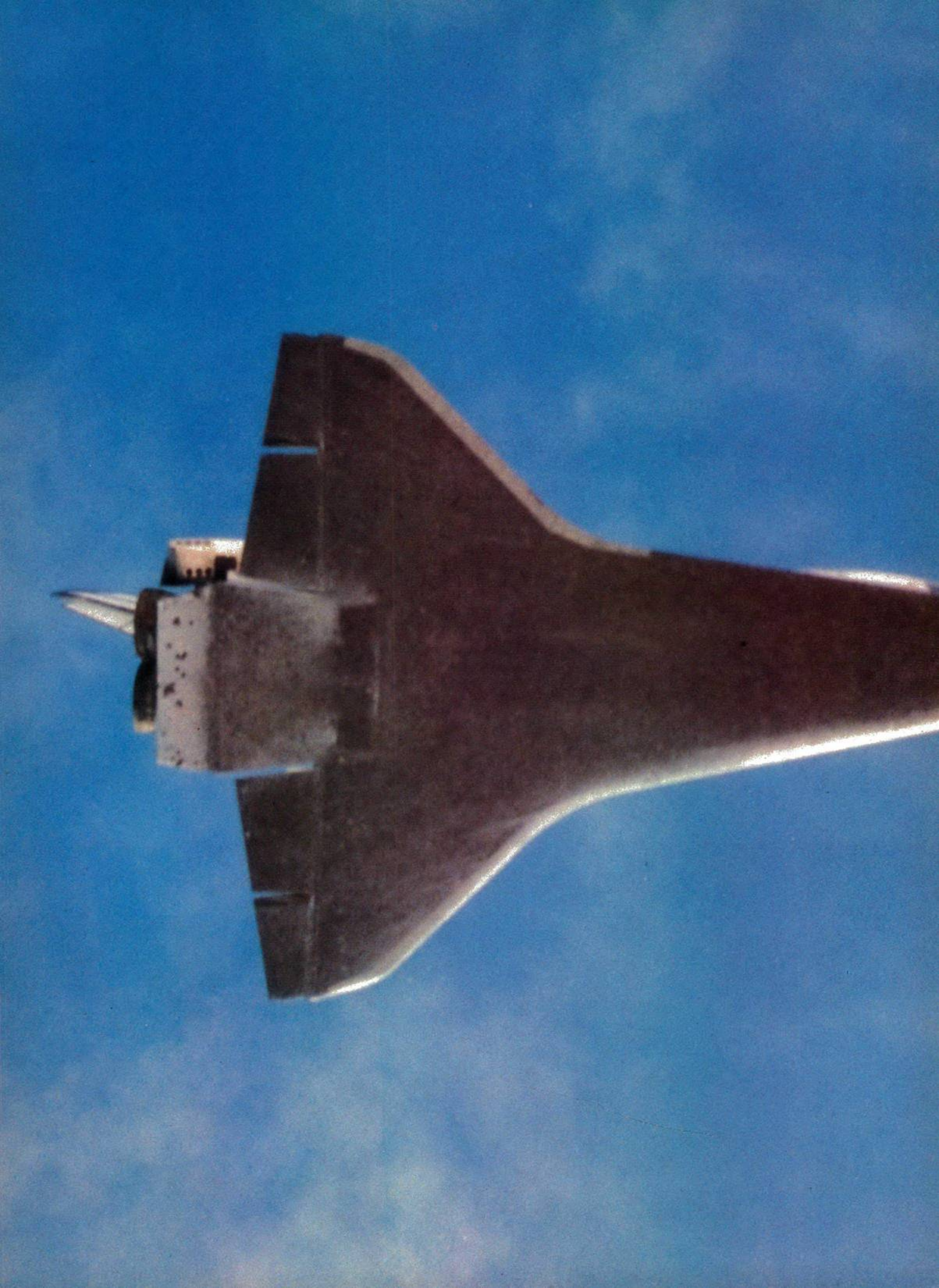


All astrophotographs shown on these pages were taken through off-the-shelf, unmodified Meade 8″ Model 2080 Schmidt-Cassegrain telescopes. For further technical details on these and many other astronomical photographs, send for your free copy of the Meade Schmidt-Cassegrain Astrophoto Brochure. (Alternately, the complete Meade 52-page General Catalog is available at $3.00 by First Class Mail and includes the Astrophoto Brochure at no additional charge.)

Key to Photographs

1, 2, 3, 5, 7 — Leo Henzl; 4, 6, 8 — Emery Hildebrand;
9 — John Sanford

1. Orion Nebula M42; exposure time 50 mins. **2.** Andromeda Galaxy M31; 60 mins. **3.** Galaxy M82; 60 mins. **4.** Milky Way in Sagittarius (50mm piggyback photo). **5.** Spiral Galaxy M33; 75 mins. **6.** Spiral Galaxy M51; 60 mins. **7.** Galaxy NGC 253; 40 mins. **8.** Omega Nebula M17; 40 mins.; **9.** Moon — Clavius region; 1-sec.



ASTRONOMY

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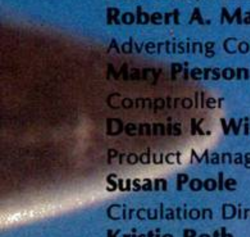

Cover: NASA rolls out the Shuttle on its Rotating Service Structure several days before launch so technicians can finish their final tests. Shown here in the 2 a.m. procedure that takes three hours to complete, *Columbia* turns slowly on its pad under the glare of spotlights. These pages: Entering the atmosphere at more than 25 times the speed of sound, the unpowered orbiter is now an elaborate glider rapidly descending to its new landing site at White Plains Test Facility. A chase plane photographed the heat-absorbing tiles on *Columbia's* underbelly. NASA photos.

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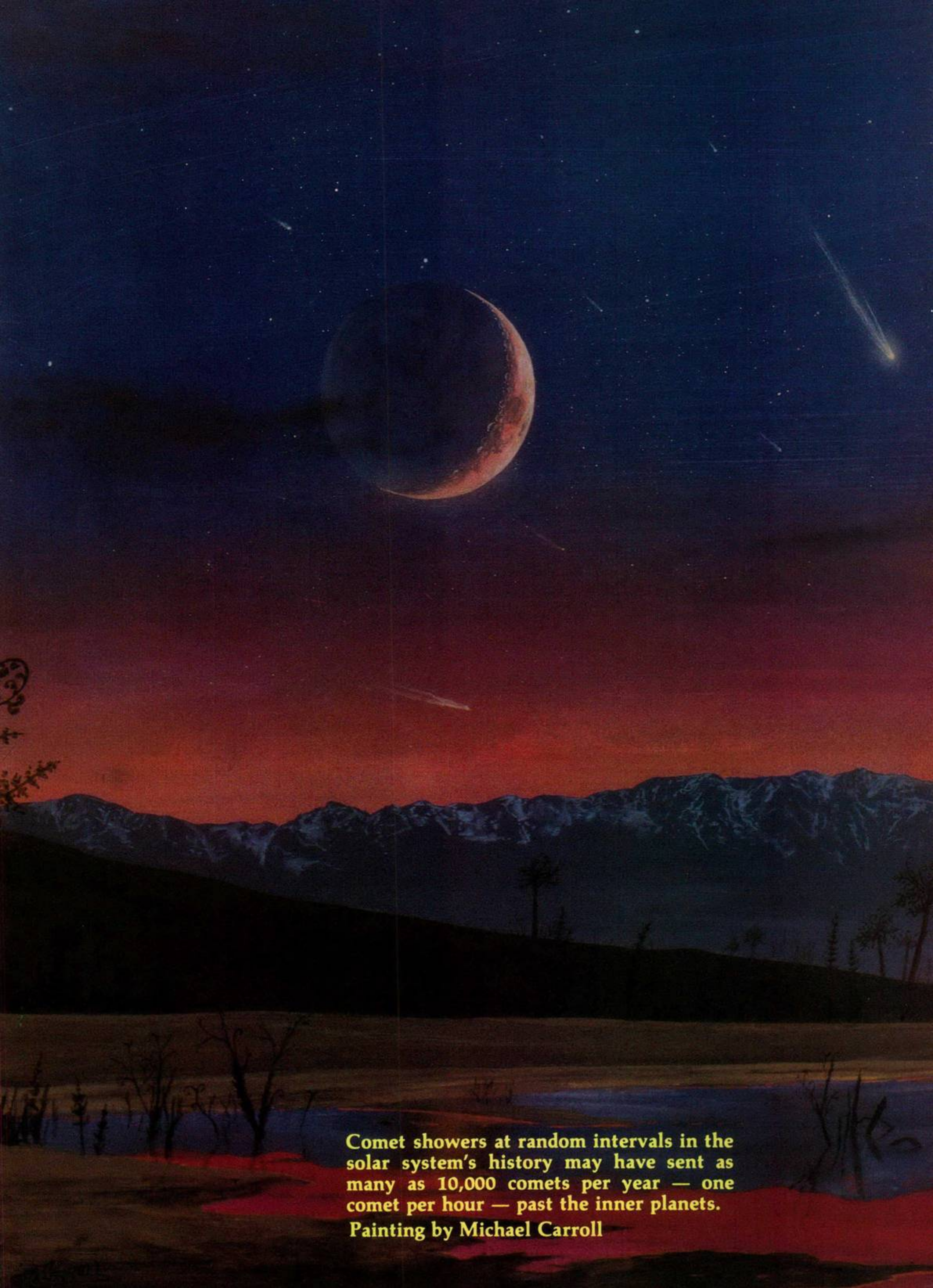
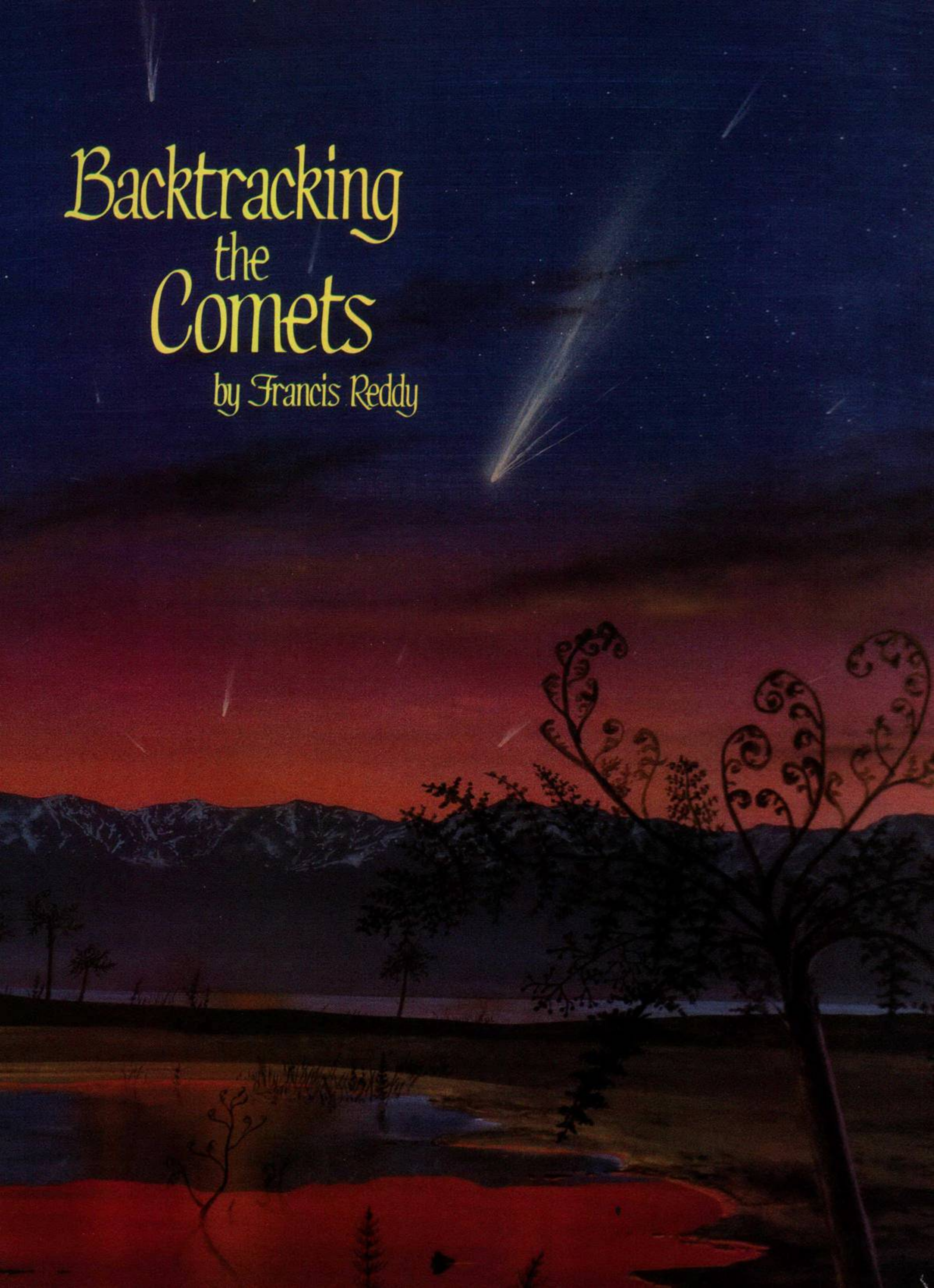


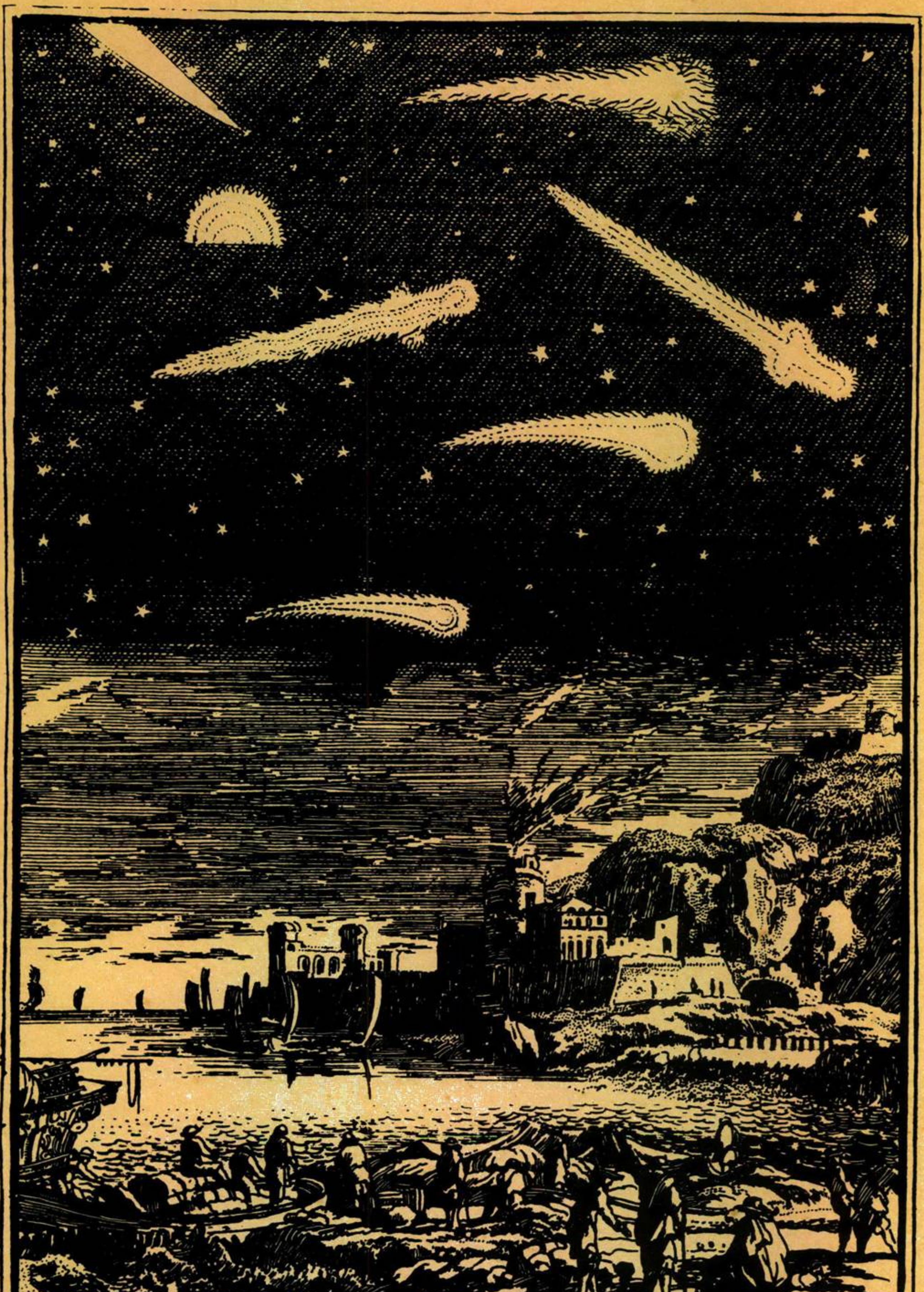
Comet showers at random intervals in the solar system's history may have sent as many as 10,000 comets per year — one comet per hour — past the inner planets.

Painting by Michael Carroll

Backtracking the Comets

by Francis Reddy





Comet types from Mallet's *Description de L'Universe, 1683.*

To ancient minds, the saber-like appearance of a brilliant comet was a harbinger of war and famine, an ethereal weapon forged by spirits. Although our ancestors were familiar with the gradually shifting positions of the planets, comets appeared suddenly and unpredictably. Imagine a bright comet, edging closer to the Sun each day, its frightful tail stretching halfway across the heavens; it kisses the Sun and, rising higher in the sky, fades into oblivion. Such a sight must have filled even the stoutest of hearts with terror.

Comet West. Photo by A.K. Stober and Andrew Smith.

The terror is gone now, but the puzzles of comets remain. "To astronomers," remarks Dr. Paul Weissman, a member of the Jet Propulsion Laboratory's Earth and Space Sciences Division, "comets are sort of the misfits of the solar system — every good idea about their origin seems to have some major drawback."

Astronomers have long tried to supplant the mystique of the comet with facts, but instead have added some lore of their own. Many of them believe comets to be tidbits of the original material from which the solar system evolved. A few claim that cometary collisions with the Earth could have led to the so-called "terminal Cretaceous event" — the disappearance of 70% of the species on Earth some 65 million years ago. And a handful of others suggests that such collisions may have brought to our planet some of the elements necessary for life.

But just where do comets come from? This wasn't much of a problem for the ancient Greeks, for although some of them entertained very sane ideas about comets, the opinion of Aristotle was that the "hairy stars" were meteorological phenomena — a weather problem rather than an astronomical one. This verdict was not seriously challenged for fifteen centuries. Only when the Danish astronomer Tycho Brahe used parallax to find the comet of 1577 to be "at least six times as distant as the Moon" did these objects attain celestial significance.

The first hint of a solution to the mystery of the origin of comets did not appear until 1950, when Dutch astronomer Jan Oort announced the results of his analysis of the nearly parabolic orbits of 19 long-period comets. But why did it take until the mid-twentieth century? After all, tracing a comet's path, or "backtracking" it, should be easy with the Keplerian and Newtonian laws of planetary motion: just carefully observe its course and calculate backward. But several factors conspire to convolute this apparently straightforward problem. And part of the trouble lies in the very paths comets take around the Sun.

The periodic comets, like P/Halley and P/Encke, are easy pickings for the celestial backtracker. But they are also dead ends. They circuit the Sun in *elliptical* paths much as the planets do, though their orbits are more eccentric. The majority of newly discovered comets, however, swing around the Sun in extremely elongated, long-period paths that closely resemble open-ended curves. For this reason, the long-period comets once were thought to originate beyond the solar system.

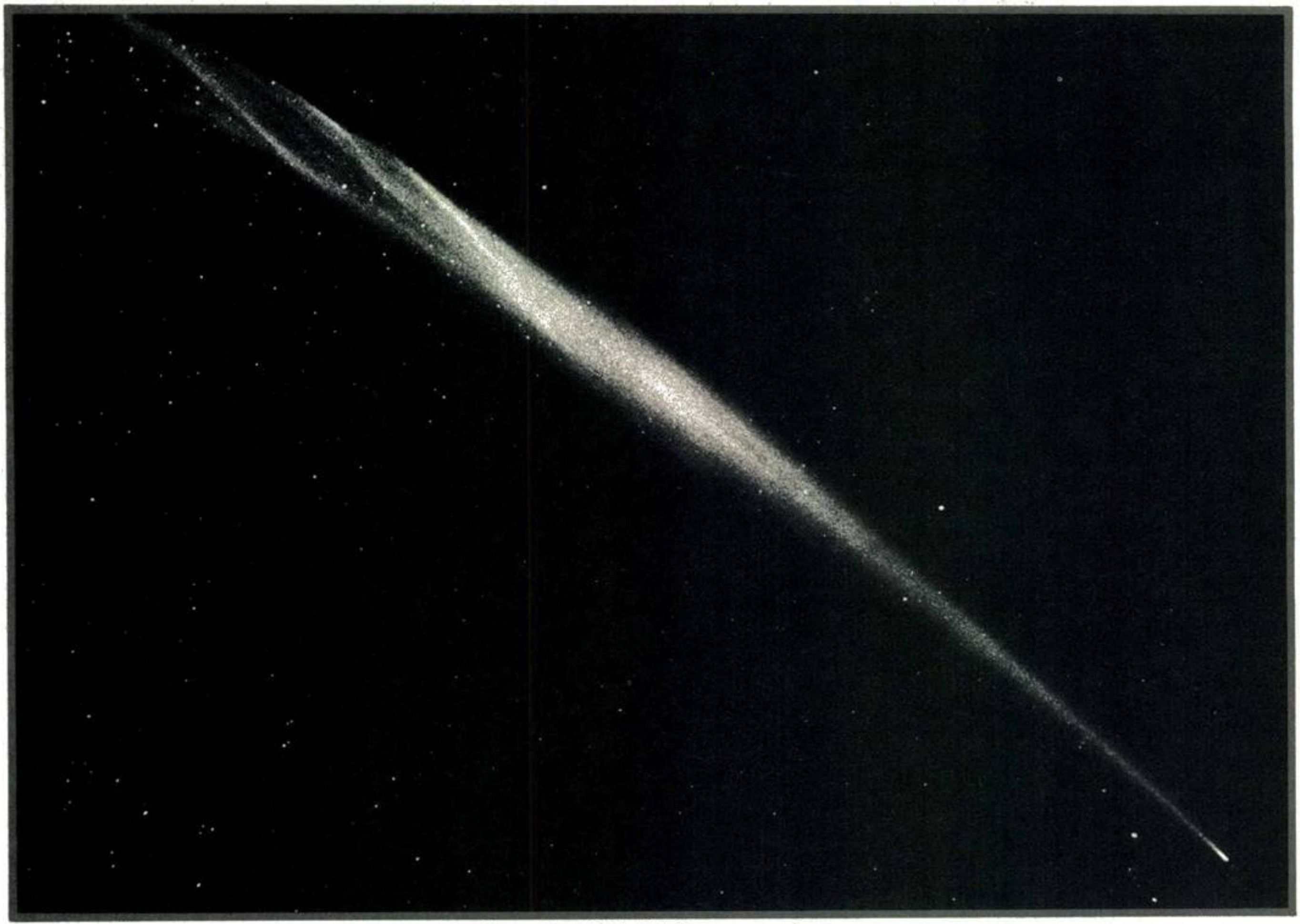
Unfortunately, a comet is usually bright enough to be observed only during *perihelion*, the portion of its orbit that brings it closest to the Sun. All orbital calculations are thus referred to a standard point near perihelion to aid in comparing different determinations. This standardized path is called the *osculating orbit* — derived from the Latin word for kiss.

Comets coming from beyond the solar system must move in open-ended curves, *parabolas* and *hyperbolas*, and not in a closed ellipse. But the osculating elements of all three paths — elliptical, parabolic and hyperbolic — are nearly identical, so it isn't easy to tell if a comet is a member of the solar system, or a transient visitor destined to return to interstellar space.

If the long-period comets were originally interstellar objects, then they *all* ought to show a tendency toward non-elliptical original orbits. But we've observed only a few comets with orbits that, within the errors of the calculations, are open-ended. Why this discrepancy?

The massive gas giants, Jupiter and Saturn, hold part of the answer. These planetary tricksters can play games with a comet's original orbit and give it a gravitational "kick" that throws it into a hyperbolic curve. They act as the solar system's vacuum cleaners by ejecting material into interstellar space, a fact that both the Pioneer and Voyager spacecraft confirmed in their explorations. Planetary perturbations can also catch a comet and trap it within the solar system: this accounts for periodic comets.

But the comet itself can cause orbital changes, too. In 1950, the same year Oort was examining orbits, Fred Whipple at the Harvard College Observatory proposed that comets are dirty snowballs — solid bodies made up of various ices intermixed with dust. This model explains how comets can change their velocities as they circle the Sun and helped astronomers understand how P/Encke seemed to be spiraling into the Sun, and Comet Halley teased observers of its 1910 approach by reaching perihelion



Comet Ikeya-Seki. Lick Observatory photo.

three days later than predicted.

Whipple believed that a comet's constituent ices would slowly evaporate when heated by the Sun, and the gases — swept back by radiation pressure and the solar wind — would form the tail. This evaporating ice would act as a rocket and push the comet away from the Sun if the nucleus was not rotating. The gas jet could either speed up or slow down a rotating comet as it moved around the Sun, depending on the direction of the rotation.

Once these effects were taken into account, no reliably observed comet showed a non-elliptical original orbit: comets must come from somewhere within the solar system — but where?

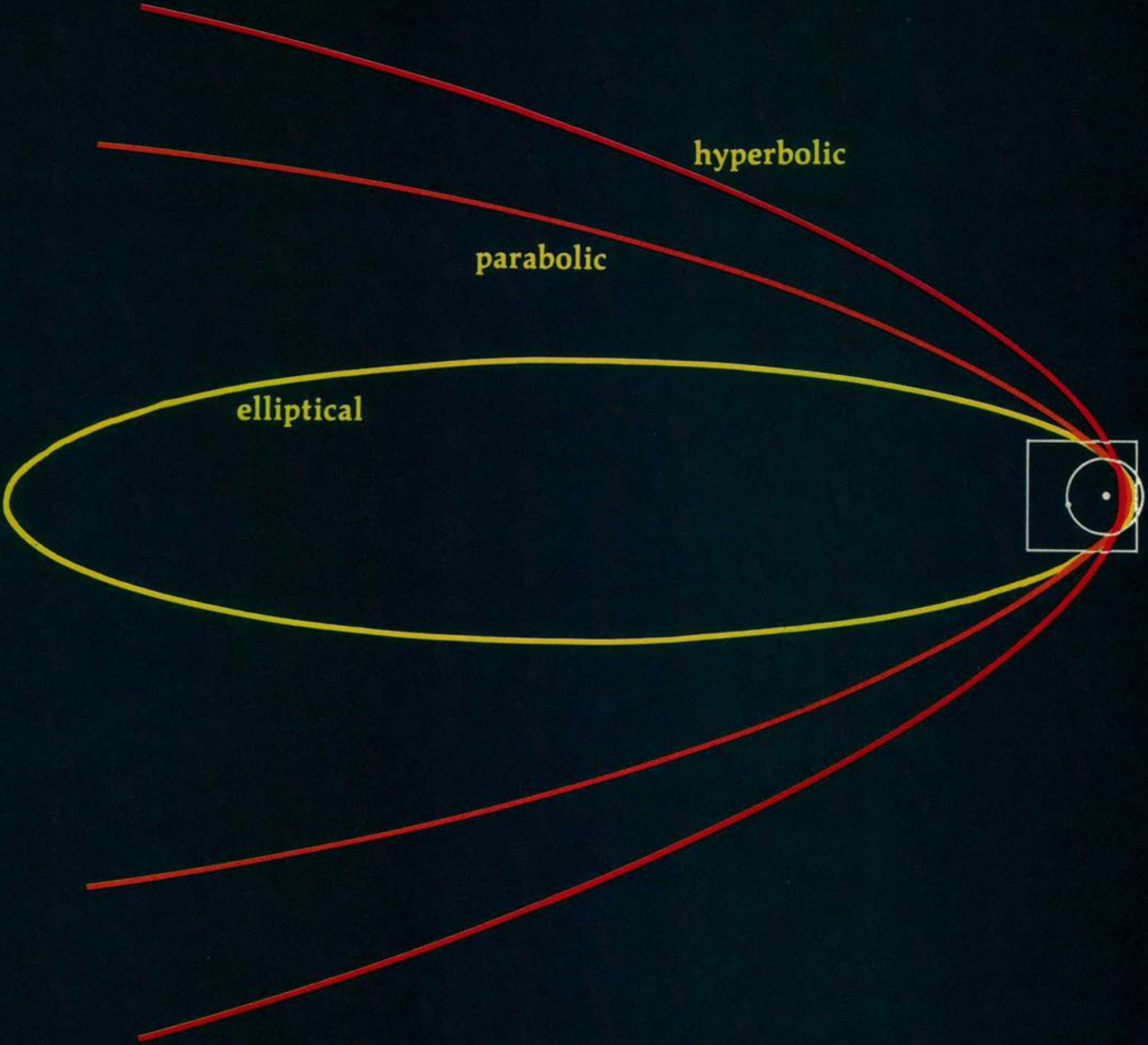
When Oort completed his analysis of comet orbits, he found that each of the 19 long-period comets he analyzed seemed to originate from a Sun-centered spherical shell hundreds of times more distant than Pluto. Later work confirmed an "Oort comet cloud" and determined its inner radius to be about 20,000 astronomical units from the Sun. Oort thought that perhaps a 100 billion comets populated this cloud, still bound by the feeble gravitation of a Sun that, from the distance of the comet cloud, would be only the most conspicuous star in the sky — 1/250 as bright as the Full Moon viewed from Earth.

Oort greatly extended our concept of the realm of the Sun, but he also found that the solar system terminated at about 200,000 AU because of the gravitational perturbations of the stars. As the solar system circuits the Galaxy, passing stars alter the stable heliocentric orbits. These stellar perturbations give the comets a nudge toward the Sun, which then pulls them into the inner solar system. Beyond 200,000 AU, the Sun's grip is too weak to prevent the comets from being ripped loose by the stars and lost to interstellar space.

The Oort cloud also explains two puzzling aspects of comet orbits: they have random inclinations to the plane of the ecliptic and about half of them are *retrograde*, moving from east to west in apparent motion. But how could the comets ignore both the plane that contains the planetary orbits and their direction? If comets are held in a shell far from the Sun, their inclinations and directions are "thermalized" — stirred up by the slightest perturbations of passing stars. They begin to move like the molecules in an ideal gas; their distribution in the shell is random, as well as their direction. That problem, at least, is solved.

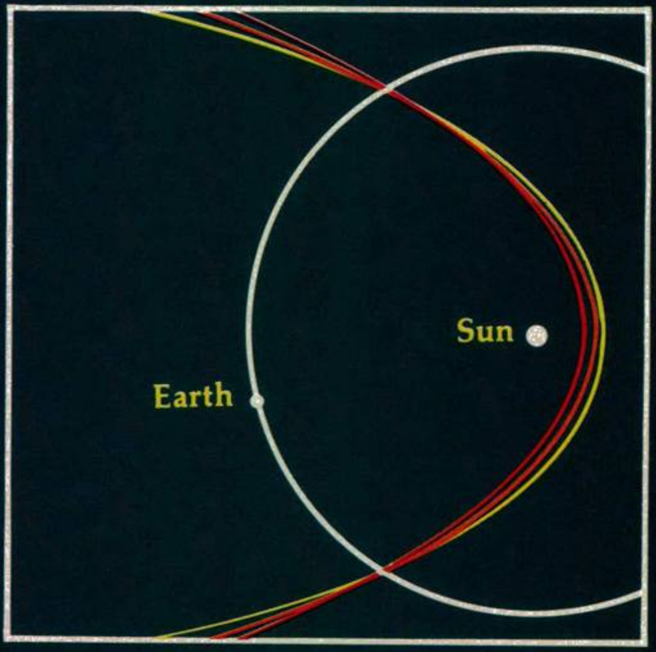
The clincher for the Oort model is its prediction of a steady-state "comet flux" in the planetary region averaging five comets per year — in excellent agreement with observation. But Dr. Jack Hills, a theoretical astrophysicist at Los Alamos National Laboratory, thinks there is another possibility: that a large comet cloud lies within the Oort cloud. If he's right, the comet flux may once have been a thousand times greater than it is now.

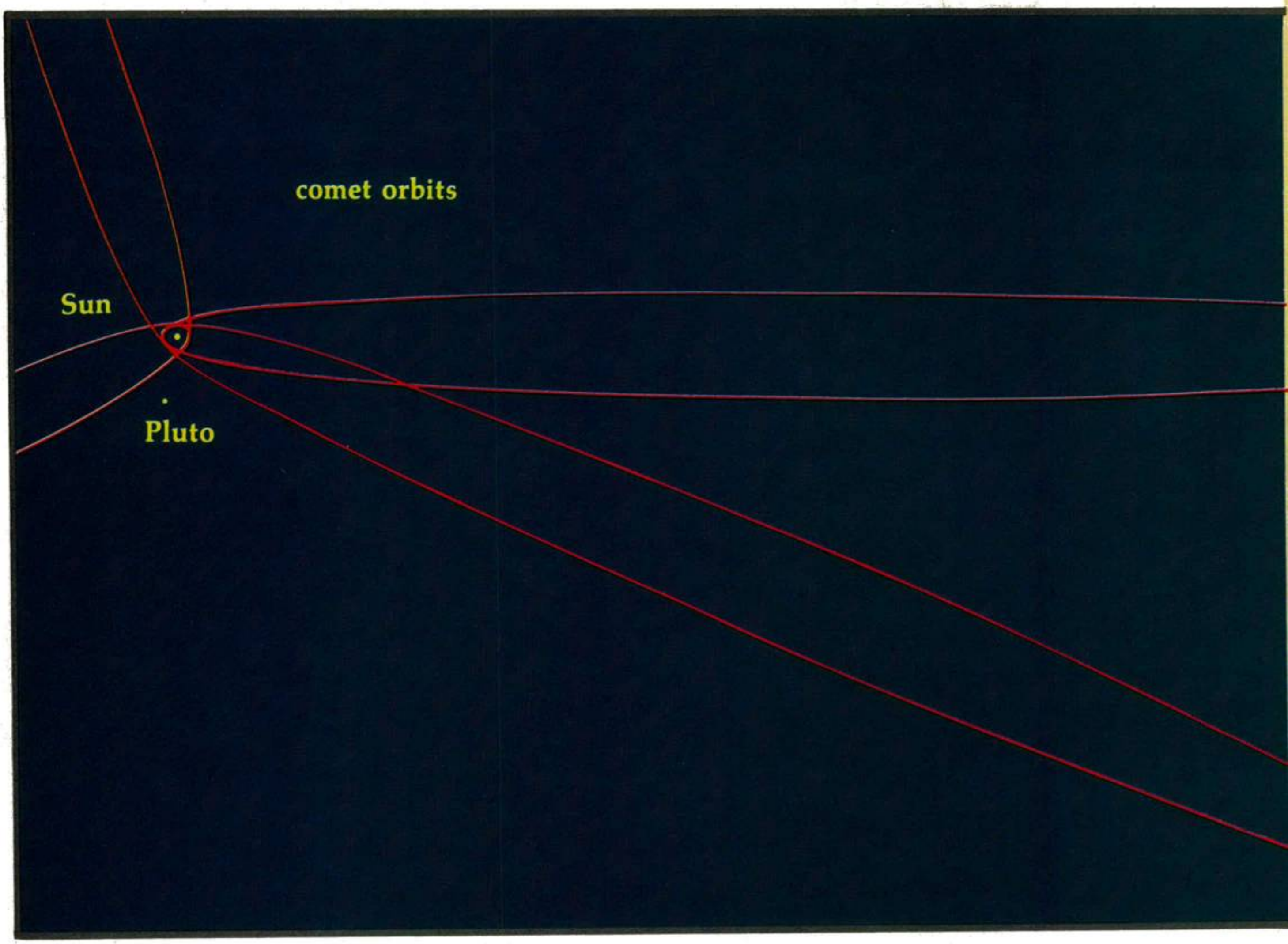
Previous studies have shared one weak point: they considered only the observed comets, those we've backtracked to the Oort cloud. But Hills has


hyperbolic
parabolic
elliptical

Pinpointing where comets come from is difficult because of the similarity of elliptical, parabolic and hyperbolic orbits as they approach the Sun. Orbital perturbations caused by planets and gases blown by the solar wind can further muddle the distinctions between the types of orbits.

Close up of boxed area





developed analytical techniques for evaluating the effect of passing stars on comets with any arbitrary orbit size. "The observed comet cloud," he concludes, "may be only the outer halo of a much more massive comet shell inside the Oort cloud." Why, then, have no comets been trailed back to the inner cloud?

Picture both comet clouds as concentric shells enveloping the solar system. Orbiting far from the Sun, Oort comets are easily affected by stellar perturbations because they are loosely bound. These gravitational tugs are strong enough and frequent enough to insure a constant trickle of these comets into the planetary region.

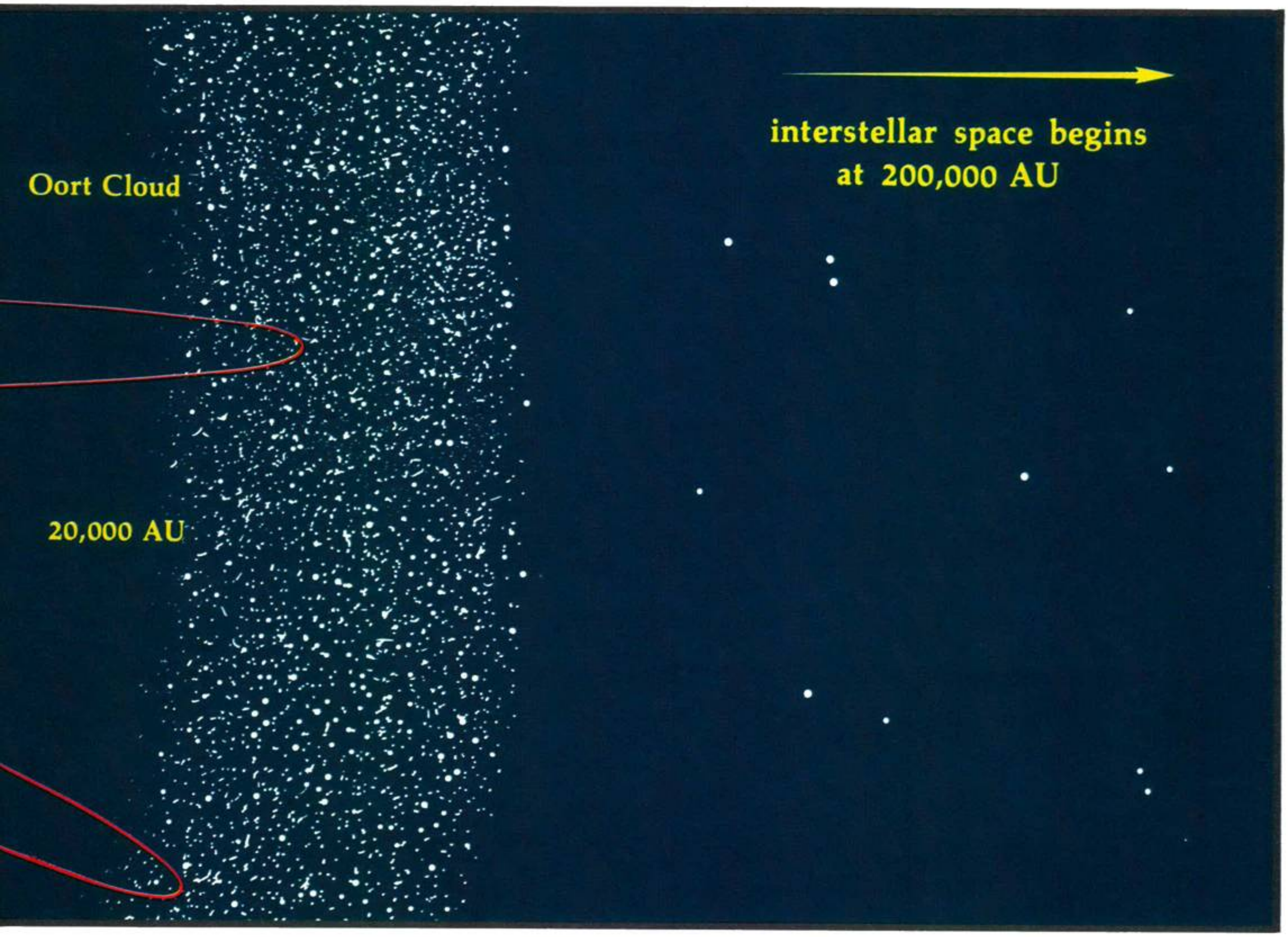
Comets of the inner cloud are much nearer to the Sun than the Oort comets — about 3,000 AU, according to Hills. These bodies are more tightly bound than those in the Oort cloud because of their proximity to the Sun, so only the rare passage of a star through the cloud can alter the orbits enough to bring these comets into the planetary region. Just because we don't see comets coming from an inner cloud doesn't mean they aren't there, it's just that they seldom get "kicked" inward toward the Sun.

Now imagine what happens each time a star of about the same mass as the Sun moves through the hypothetical inner cloud at a distance of 3,000 AU. The star accelerates everything in the solar system toward itself — Sun, planets and all. The inner cloud, though, takes most of the punishment. As it passes through the cloud, the star changes the cometary orbits, so that they fall toward it. But since the star is moving through the cloud, its passage creates a wake of disturbed comets behind the stellar intruder. Once the star leaves the solar system, the orbital changes it imparted to the comets force some of them to fall toward the Sun.

The 3,000 AU stellar passage required for Hills's model occurs once every 500 million years — so inner cloud comets may have been subjected to severe orbital alterations as many as nine times since the birth of the solar system. The result is what Hills calls a "comet shower."

The duration of a comet shower is nearly four orbital periods — about 700,000 years for comets at 3,000 AU. The intensity of a comet shower, Hills says, is about 10,000 comets per year entering the inner solar system, or nearly one comet per hour for the duration of the shower. Other considerations in his theory place about 10 trillion bodies in the inner cloud, so comet showers of such intensity are plausible — and spectacular.

Jupiter and Saturn act quickly on the shower comets, and after four excursions into the planetary region, visitors are either ejected from the solar system, pumped into the Oort cloud, or captured in short-period orbits where solar heating destroys them. With showers occurring about every 500



million years, the time between them is roughly 1,000 times greater than their duration — thus the shower comets are cleared from the inner solar system long before another star passes near enough to replenish their number.

But another loss mechanism may be at work: planetary collisions. "During a comet shower," Hills says, "about 7,000 comets come within two astronomical units of the Sun each year." Scaling up from previous estimates of Earth-comet collisions — which indicated that they occurred at million-year intervals — Hills found that anywhere from 10 to 200 comets could strike the Earth over the 700,000-year lifetime of a shower. Such intense, repeated bombardment might sufficiently upset the distribution of species on Earth to show up in the fossil record. "It is tempting," Hills adds, "to join the 'me too' parade and suggest that this bombardment could have led to the extinction of the dinosaurs."

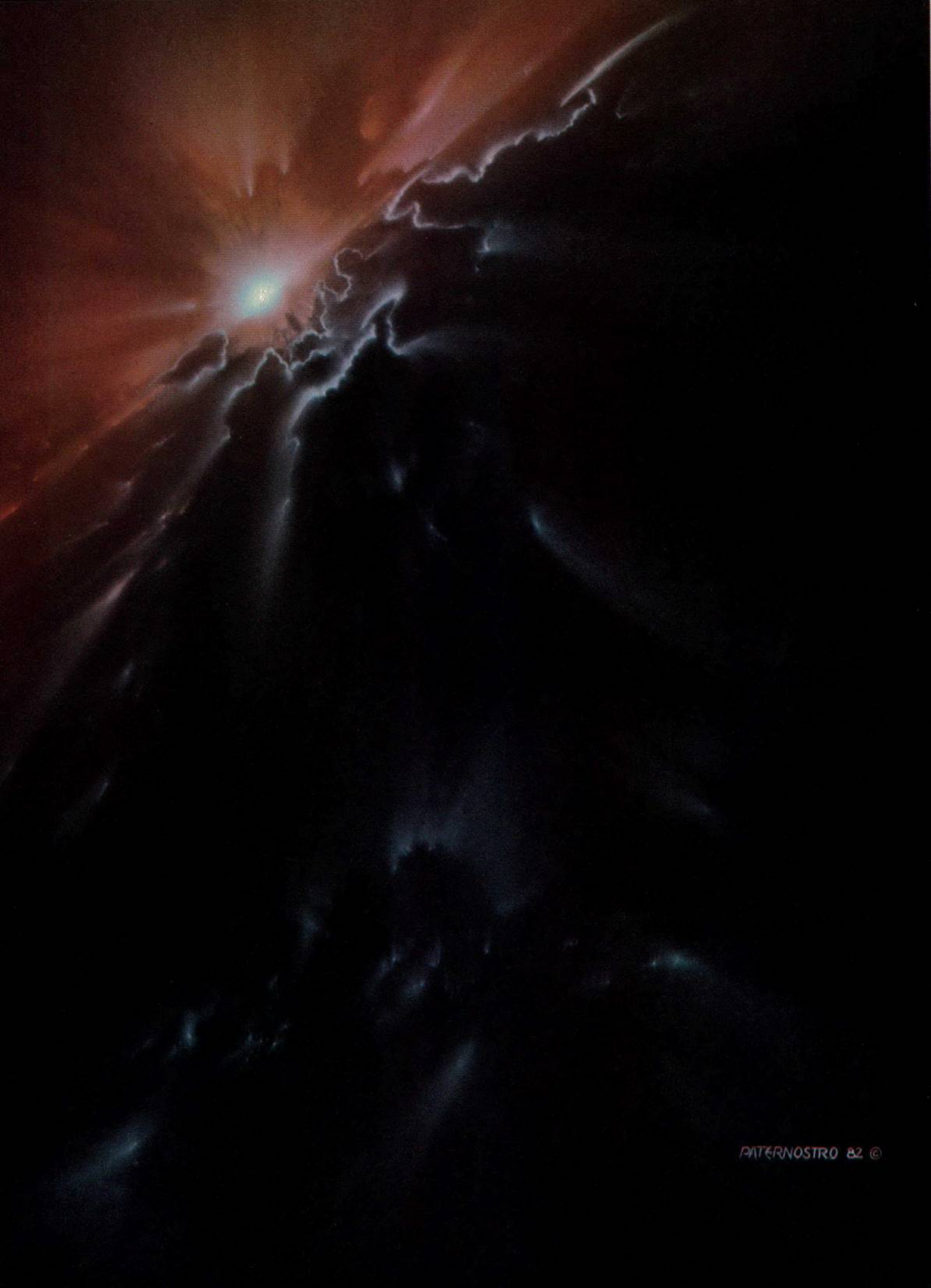
Cratering may have caused the great extinction 65 million years ago, says Paul Weissman, "but if it did, it probably occurred in bursts of small cratering, rather than in one massive asteroid impact as was originally proposed." But one problem in looking for geological evidence of comet showers that could lead to episodes of rapid cratering is the frequency of the event. In 500 million years, nearly half of the Earth's crust is *subducted.*

Subduction, one of the processes by which the Earth heals her wounds, occurs when two crustal tectonic plates run into each other. One plate rides over another plate, which is then drawn into the Earth's hot interior. A collision with a massive asteroid just 65 million years ago — not long in geological time — should leave an enormous crater, since only about eight percent of the crust of that era has been subducted. So terrestrial evidence for comet showers is lacking, and of the 200 positively identified impact sites not one is considered the right age.

But Earth is a poor place to look for ancient craters — other worlds are far less active. Eugene Shoemaker of the U.S. Geological Survey believes that comets are responsible for much of the damage seen on the saturnian moons. Warns Paul Weissman, "It's very difficult to accurately determine cratering rates, and it's nearly impossible to differentiate between a comet crater and an asteroid crater, so these ideas are very speculative."

So evidence for past comet shows may be difficult to find. But the question comet theorists find most difficult to answer is how comets got to the Oort cloud in the first place. In order to examine this problem, we must leap backward in time to the birth of the solar system . . . .

Eons ago, in the midst of some great cloud of interstellar gas and dust, a pocket of material became unstable — possibly because of internal eddies or the shockwave of a distant supernova. The cloud fell in on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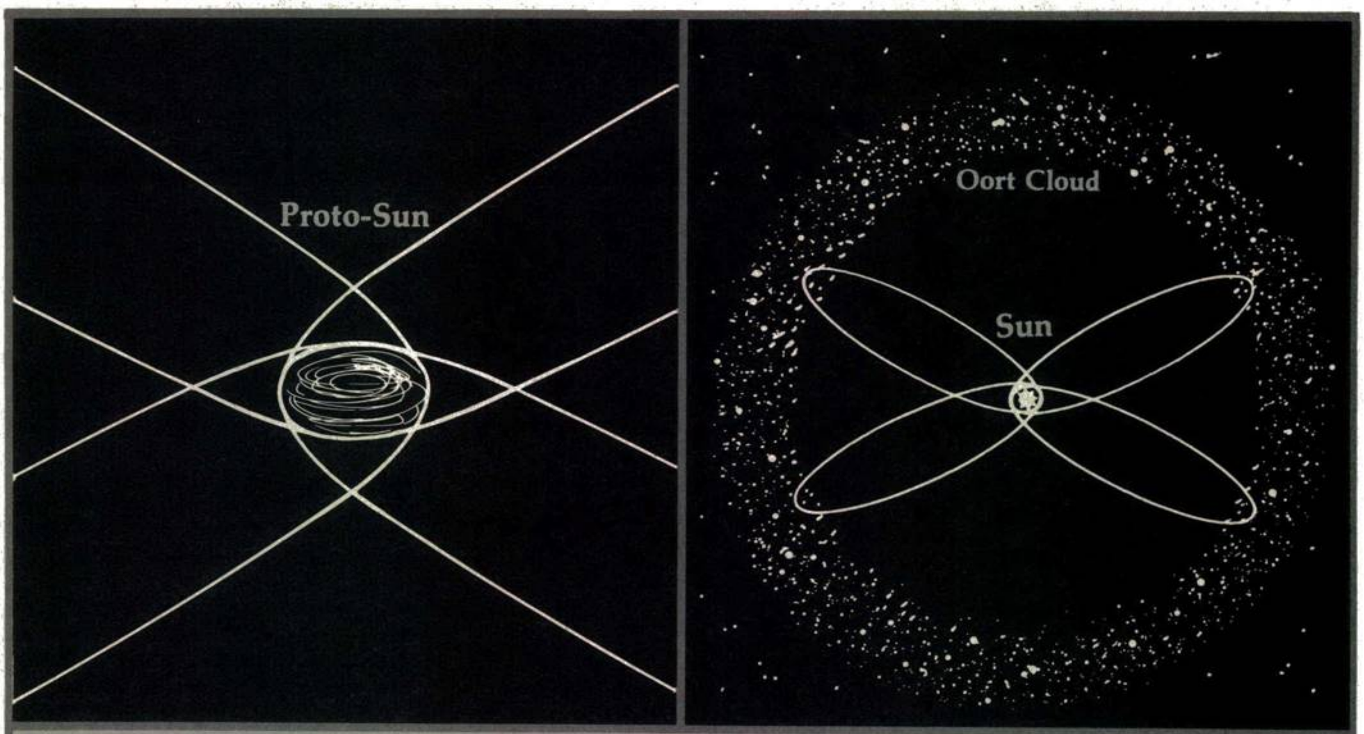


Comets approaching a rapidly shrinking proto-Sun would be drawn into elongated elliptical orbits as the proto-Sun decreased in size. Stellar perturbations could then alter these orbits to form the Oort Cloud.

High density and low temperature in the collapsing proto-Sun may have flushed out gas and aggregated opaque dust to form comets in a relatively short 400 years. Painting by Mark Paternostro.

itself, growing denser and hotter. It began to rotate, and as it collapsed, its rotation increased to conserve angular momentum. Then the cloud flattened into a disk with a proto-Sun glowing at its center under the heat of its own contraction. Tiny grains of matter cooked in the stars collided; a few stuck together. Eventually, all the material observed in the solar system was built by this slow process of accretion . . . .

The solar system emerged about 4.6 billion years ago from a rotating disk of gas and dust, but just how comets fit into the scheme is puzzling. Complicating matters, we have conflicting bits of information about comets: they are solid, icy bodies, yet they are observed in a part of the solar system where the density at creation was too low. They could not have formed where they are now. But, if they didn't form in the Oort cloud, how did they get there?

One idea, proposed but now abandoned by A.G.W. Cameron of the Harvard-Smithsonian Center for Astrophysics, suggested that the cloud of interstellar gas that formed the solar system was accompanied by smaller clouds that formed the comets. Cameron argued that most of the stars in the galaxy are less massive than the Sun, so cloud fragmentation must continue to at least one-tenth of a solar mass. Perhaps fragmentation went even further, producing many rotating fragments that assumed orbits around the proto-solar system at about the distance of the observed Oort cloud.

These fragments would be ideally placed for comet formation; the density of the area would be high enough to allow solid bodies to accrete and cold enough to insure that ice was the predominant constituent — and, of course, it supposes they were formed where they are now. The remaining gases in the fragments would evaporate from the heat of other stars that formed near the Sun.

Cosmochemists favor the cloud-fragment model because comets seem to be made out of many elements we find in interstellar clouds. But this theory is probably not correct because if the fragments had some original angular momentum — a reasonable assumption — stellar perturbations could not have randomized them. If the theory is right, comets should enter the solar system from certain preferred directions. They don't. Comets seem to arrive from points all over the celestial sphere.

A new model proposed by Cameron places comet formation in the outer part of the accretion disk — a few hundred astronomical units from the Sun. Again, both the density and temperature of this region are appropriate for making dirty snowballs, but now the model must transport them into the Oort cloud.

Imagine a body orbiting the Sun at several hundred astronomical units. Such a body would "see" the center of mass of the solar system as the entire accretion disk, not just the Sun. If we reduce the center of mass by nearly 50 percent in a time that is short compared to the comet's period at that distance, then its orbit will be drastically altered. The perihelion distance will increase, the angle of inclination to the ecliptic will change, and the comet will assume an elongated elliptical orbit. Stellar perturbations could then alter these orbits to form the Oort cloud. The planetary orbits will not be altered much by all this because the planets react to the Sun as the center of mass, not the Sun-disk complex.

Since Cameron thinks the accretion disk amounted to about twice the mass of the present-day Sun, his theory means the star system had to lose nearly one solar mass of material. And that is possible. Before the Sun began its nuclear fusion, shining only by the gravitational potential energy released by its contraction, it entered what is called the T Tauri phase and blew a gale-force version of the solar wind — a stream of charged particles from the Sun — through the accretion disk. The effect of this stellar wind is to "clean up" after the solar system's formation, blowing out the gas and dust that never accreted. "It's a rather vague term," admits Cameron, "and no one really knows whether the T Tauri wind can push that much material out of the solar system in just a few thousand years."

But he suggests another mechanism to account for the mass loss. The Sun probably formed in an OB association similar to the Trapezium in Orion. When these hot young stars turn on, their surface temperatures increase a few hundred times. Their ultraviolet radiation would heat the outer layers of the solar nebula, and the increased thermal velocity of the gas could exceed the escape velocity of the accretion disk.

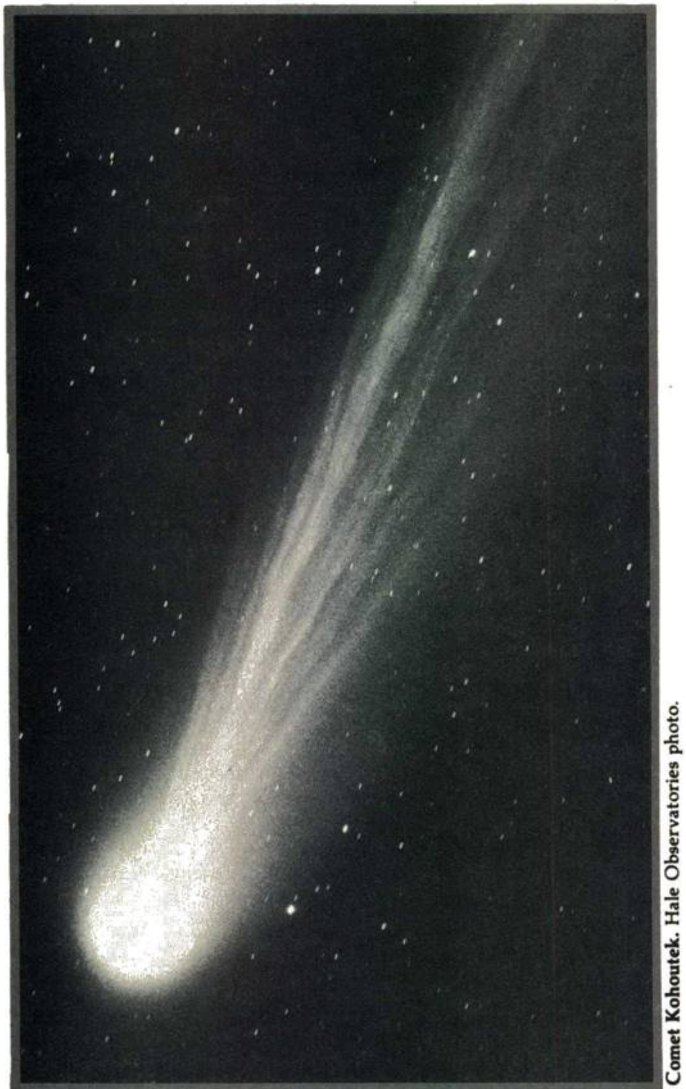
Critics of Cameron's theory find both methods of mass loss hard to believe. Particularly disturbing is the sensitivity of his model to the amount of mass lost: 48 to 49 percent of the accretion disk must be flushed out of the solar system or you don't get the Oort cloud.

Since the problems with Cameron's ideas are difficult to resolve, theorists have tried placing the comets closer to the Sun. The most widely accepted theory at present suggests that comets accreted in the region of Uranus and Neptune. "This idea has the most plausible dynamics," says Paul Weissman. If comets formed there, gravitational interactions with these planets ejected them into the Oort cloud region.

Although some astrophysicists doubt that the Uranus/Neptune region was cold enough to breed comets, the best criticism is its sheer wastefulness. Planetary accretion is thought to be reasonably efficient, so if comets formed near Uranus and Neptune, they should have wound up in those planets.

While each of these theories "creates" the Oort cloud in one way or another, none of them could create the hypothetical inner comet cloud. Not surprisingly, Jack Hills has his own ideas about how the comets were formed.

Hills believes that comets were created in the outer edges of the collapsing proto-Sun — not in the much smaller planetary accretion disk that eventually formed. The proto-Sun may have extended to about 5,000 AU, so the comets are formed at about the same distance as the inner cloud. He suggests that the proto-Sun collapsed in two stages: the core collapsed first, creating a central object initially brighter than the present-day Sun, and the remaining material fell into this luminous core over a long period of time.



Comet Kohoutek. Hale Observatories photo.

What's in a Comet?

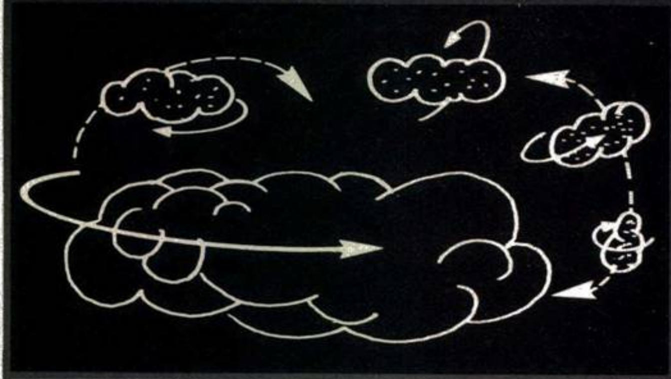
Fred Whipple's "dirty snowball" model of the comet nucleus revolutionized ideas about the composition of comets. Prior to 1950, the predominant theory was that comets were loose conglomerations of gas and dust. But short-period comets proved to be a problem for this idea, and astronomers were both puzzled and annoyed by the continued existence of such supposedly diffuse material.

Whipple's snowball was originally thought to be made of methane and ammonia ice. These ices have never been observed in comets, but were thought to be likely parent molecules of the observed carbon, nitrogen, and other gases ionized by sunlight and swept into the tail. "At present," says Zdenek Sekanina of the Jet Propulsion Laboratory, "the parent ices now believed to exist in the comet nucleus are methyl cyanide and hydrogen cyanide."

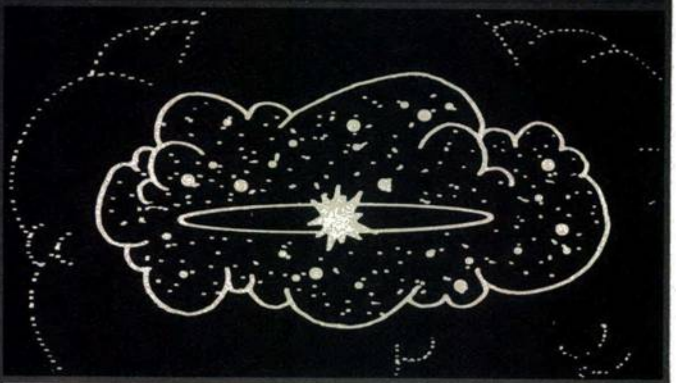
The exact composition of the snowball is uncertain, but Sekanina says, "We know that there are some metals, at least in the Sun-grazing comets, and silicates." Some of this information is found by observing the shower meteors, all of which appear to be associated with comets that have broken up.

Sekanina believes that the European Space Agency's Giotto mission to Comet Halley will clear up many of the remaining problems with the snowball hypothesis, but remarks that one thing is certain: "When we talk about comets, we are still only guessing."

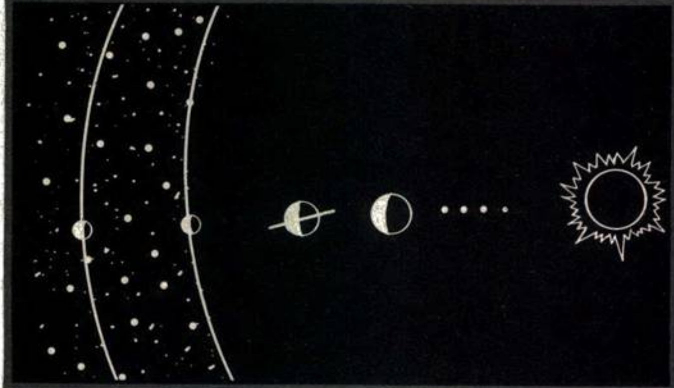
Comet Formation Theories



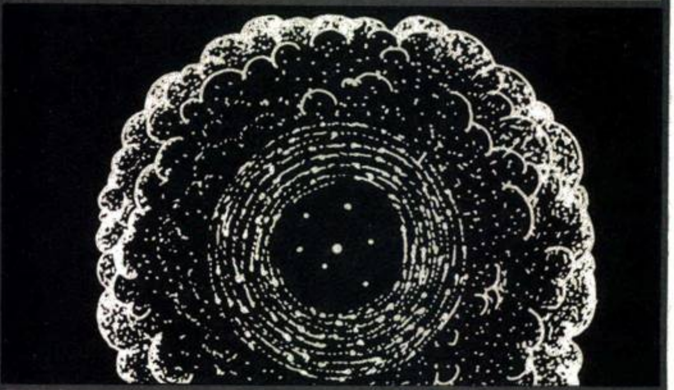
Fragmented Nebula
Pro: Comets show spectral lines similar to those of interstellar clouds.
Con: Stellar perturbations probably could not have removed original angular momentum.



Outer Cloud
Pro: Comets could drift into the Oort Cloud.
Con: Requires massive solar nebula and a T-Tauri stage mass loss of about 50%.



Uranus/Neptune Region
Pro: Comets form in a dense portion of solar nebula.
Con: Inefficient; most of the mass should have been drawn in by Uranus and Neptune.



Proto-Sun Radiation Pressure
Pro: Comets formed in outer portion of dense proto-Sun.
Con: Requires two-stage formation of proto-Sun.

The material in the proto-Sun at a distance of several thousand astronomical units meets our requirement for high density and low temperature. But in this model, the comets must form in a very short time so they don't end up in the hot core. Time was no problem in the other theories, for the comets could form by the gradual accretion of particles in millions of years. But we now need some other mechanism to form the comets — in hundreds or thousands of years instead of millions.

If the core of the proto-Sun collapsed first, Hills reasons, then the pressure of its radiation on dust in the remaining material might be the driving force behind comet formation. Gas would be flushed out by the light of the proto-Sun; opaque dust would be pushed together.

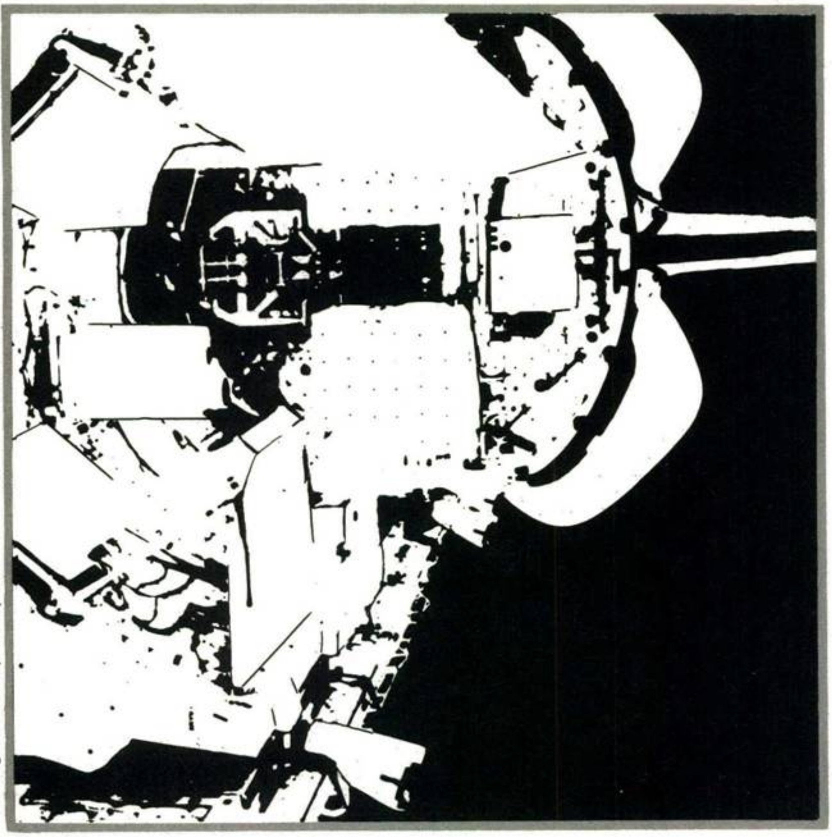
But can this mechanism make comets in just a few hundred years? Hills answers yes. His calculations show that comets at 3,000 AU could have been formed by radiation pressure compaction in just 400 years.

If we accept that comets are created in the inner cloud, then we're stuck with somehow placing them in the Oort cloud. Again, passing stars come into play. They alter the angular momentum of these inner comets and knock them inward to the planetary region, where Jupiter and Saturn quickly act to pump the comets outward to the Oort cloud. Thus the Oort cloud we observe is the required final product of any comet cloud with a radius of 1,000 AU or greater!

Although the dynamics are sound, the Hills theory is not without weak points. "We just don't know the conditions of the collapse of the proto-Sun," Hills said. If it didn't collapse in two stages, or if the core was considerably less luminous than Hills supposes, then the formation mechanism falls apart. This doesn't necessarily preclude the existence of comets in an inner shell. But it does make us search for another mechanism capable of making the comets in a short enough span to keep them from crashing into the Sun.

Comets are almost certainly the leftovers from the creation of the solar system. We have backtracked the comets in both space and time, yet we have found no certain solution to the mystery of their origin. Comet showers or not, these bodies have many more surprises in store for us. They are indeed the misfits of the solar system, spectacular to the eye, intriguing to the mind, but very far from being understood.

Frank Reddy is a copy editor for the American Institute of Physics's Astronomical Journal *and a free-lance science writer.*

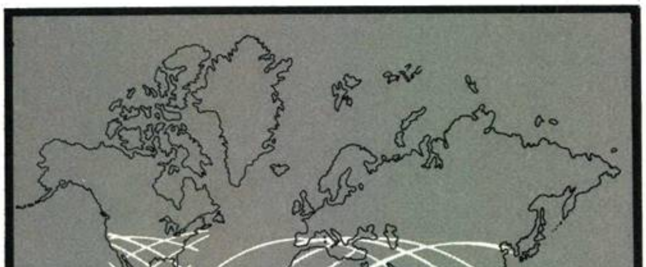


All images courtesy NASA/JPL.

The SIR-A package nestled within the Shuttle's cargo bay.

Smile, You're On Radar!

by Michael Kobrick



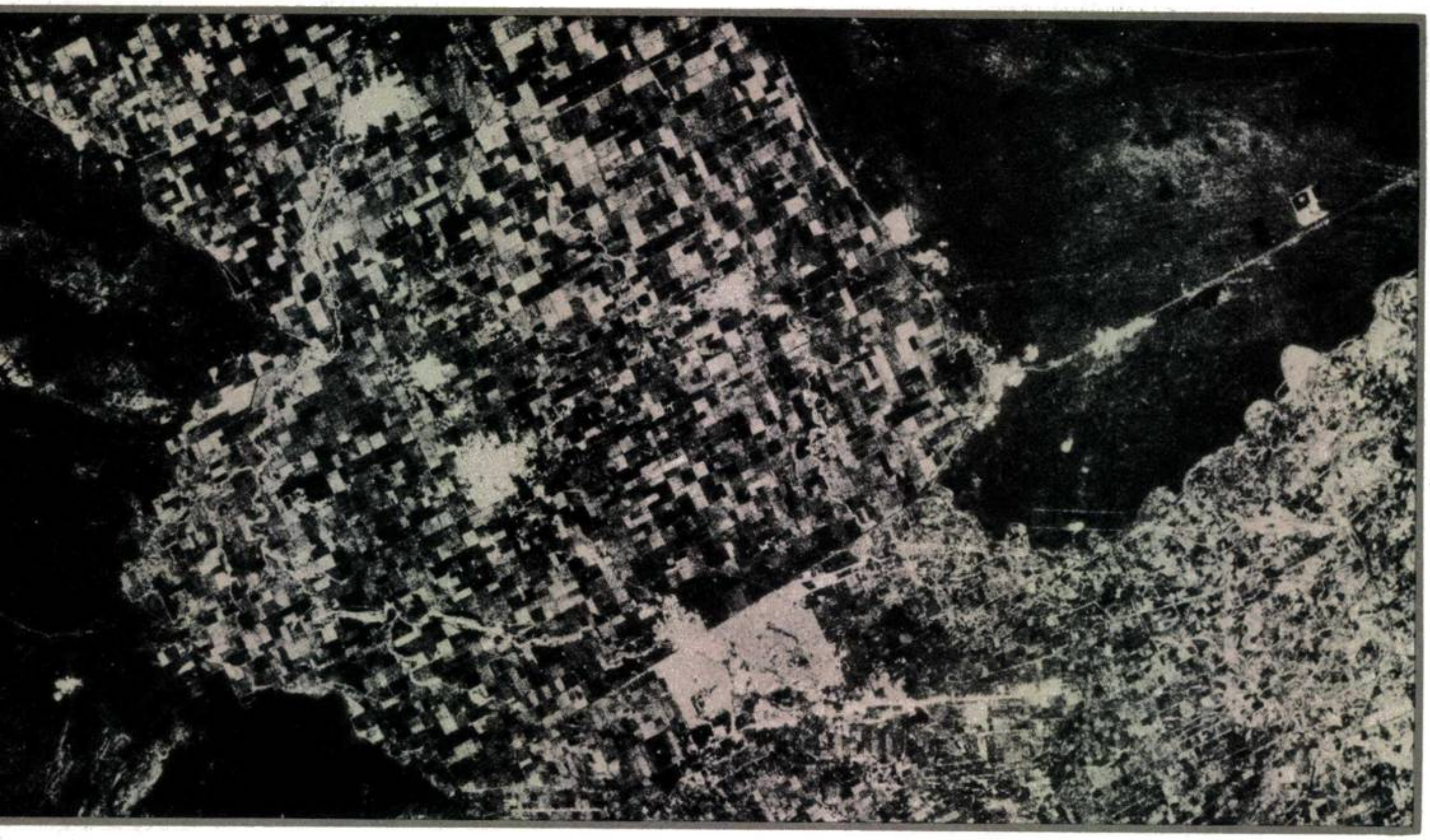
SIR-A imaged nearly 4 million square miles of the Earth's surface along the paths shown. Passes over Cuba, El Salvador, Guatemala and Nicaragua hint that SIR-A is already helping NASA pay back the Department of Defense for its shuttle funding.

The second launch of the Space Shuttle *Columbia* on November 12, 1981, marked two important milestones in man's exploration of space. Not only was it the first time a space ship had been re-used, but for the first time the Shuttle carried a scientific payload — one with great significance for future exploration of the planets.

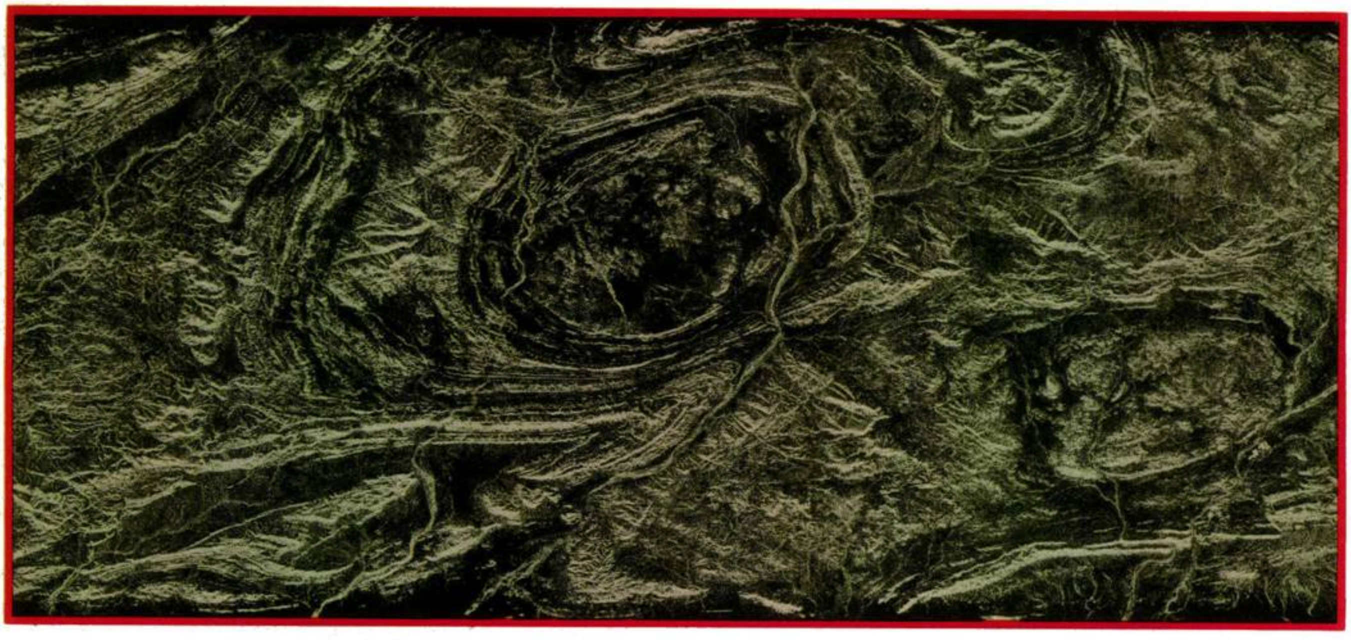
If we want to continue the dramatic and scientifically important series of discoveries that Mariner, Viking and Voyager provided during the '60s and '70s, we must depend on the Shuttle. The era of launching our robots and cameras with expensive, one-shot "roman candles" — Saturn Vs, Centaurs and other rockets — seems to be over. Hereafter *Columbia* and her sisters will move planetary spacecraft into Earth orbit where an upper stage will kick them on their way toward deep space. This should cost less and also deliver higher reliability, since the spacecraft will remain accessible and even recallable until they leave Earth orbit. Roman candle launches put these delicate instruments out of our reach during the critical launch phases when they are subject to the greatest stresses and vibration.

Inside the payload bay at launch time for STS-2 sat a collection of five scientific instruments known as OSTA-1, after NASA's Office of Space and Terrestrial Applications. Included were an infrared radiometer for identification of rock types, a set of cameras for automatic location of ground features, an ocean-color detector for finding concentrations of algae and schools of fish, an air pollution detector, and, most significantly for fans of planetary exploration, an imaging radar.

Although radar imagers have been under development for a number of years and have successfully operated on board high-altitude aircraft, they have only recently found their way onto Earth-orbital missions. The first was part of the payload of SEASAT, an oceanographic research satellite launched in May 1978. Its radar was designed to return pictures of the ocean surface and therefore used an imaging geometry not geared for geologic mapping. But the excellent shots of mountains, canyons and other land



A 30 x 60 mile area of Southern California's Imperial Valley bordering Mexico.



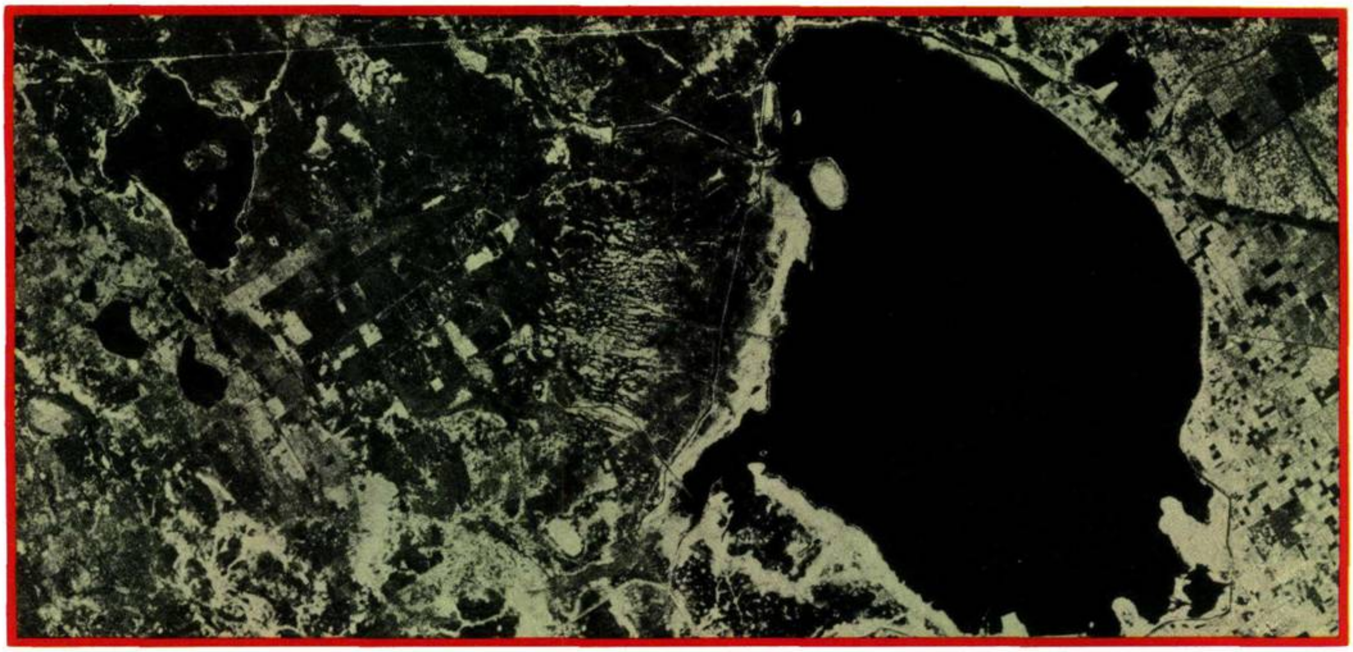
Western Australia's Hammersley Mountains, the first image received from SIR-A's flight aboard STS-2.

surfaces it sent us alerted many photogeologists to the potential of this new remote sensing tool. (See "Alien Eyes," ASTRONOMY, January 1980.)

To find out what a geology-oriented instrument could do, NASA began planning Shuttle Imaging Radar (SIR-A) and scheduled it for the OSTA-1 payload. Instead of pointing its antenna only 20° away from straight down and creating distorted images of topography as SEASAT had done, SIR-A "looked" out at 50° to produce pictures with the almost photographic geometry that remote sensing experts are accustomed to interpreting.

The same imaging angle had been planned for the recently scrapped Venus Orbiting Imaging Radar (VOIR) mission which would have mapped our sister planet near the end of this decade. Planetary scientists need radar — or a lander — to look at Venus because its planet-wide cloud cover makes ordinary cameras useless.

Another similarity to the scrubbed VOIR lies in SIR-A's operating wavelength of 23 centimeters. Electromagnetic waves of this length produce images quite different from those obtained at visual or infrared wavelengths, which are in the range of several hundred *nanometers*, or billionths of



Central Florida's Lake Okeechobee and smaller Lake Istokopoga. Bright areas are swamps and wetlands.

a meter.

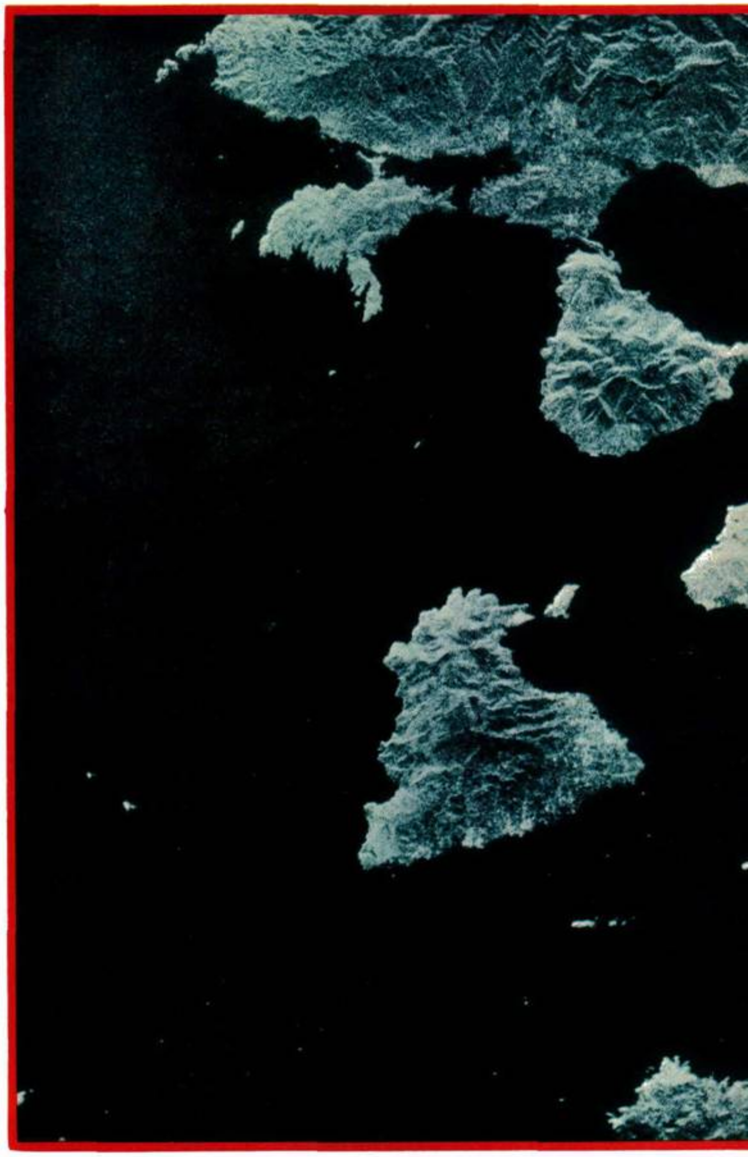
The scattering of light or radio waves depends most strongly on facets of the target that are approximately the same size as the waves themselves. Since the atoms that make up the target are also measured in nanometers, the most important elements in light scattering are *electronic transitions*, the changes in position of the electrons that surround those atoms.

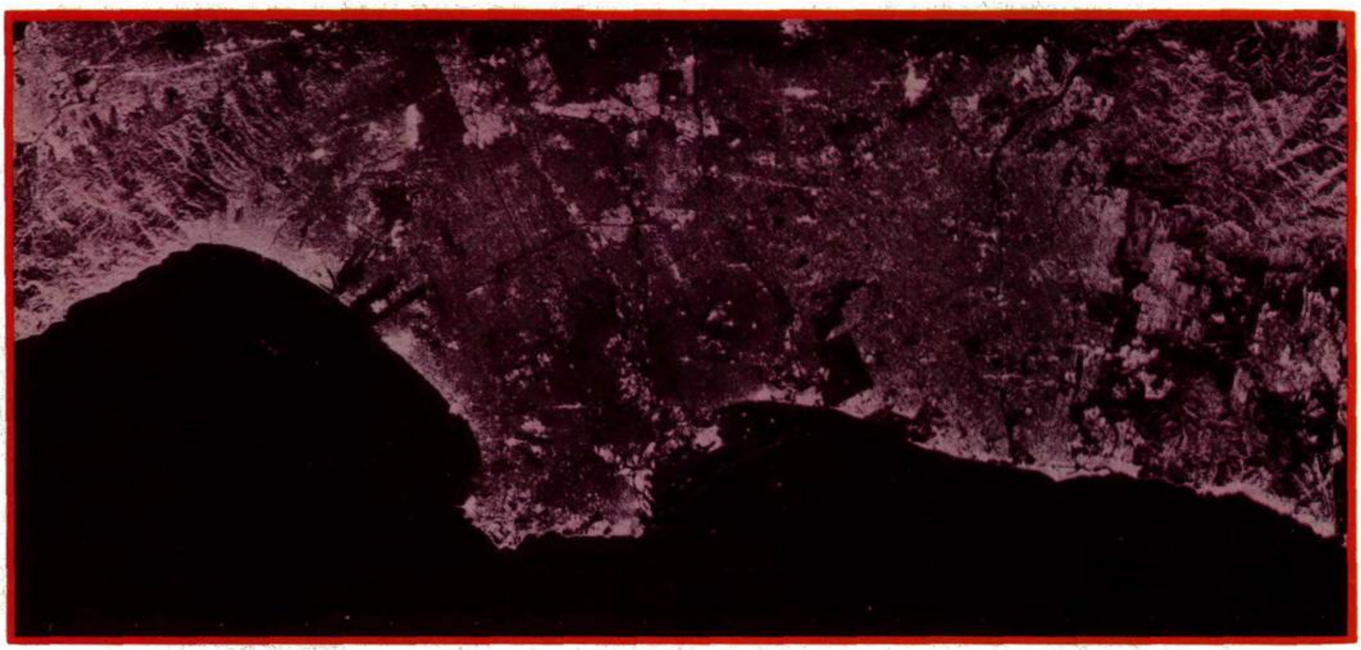
For the much longer radio waves, these electronic transitions are relatively unimportant. The more significant measurements are of objects or slopes in the scene that are 23 centimeters or larger — football-size and up. This increased sensitivity to large objects makes radar images more useful than photographs for analyzing topography, but limits its usefulness in measuring the electrical properties of rocks that indicate their composition.

The international team of scientists that planned and executed the SIR-A experiment had the instrument ready to fly about a year before the launch date. And the delays in the construction of *Columbia* gave them even more time to plan the experiment operation down to the smallest detail. SIR-A was designed to image a 50-kilometer swath along the ground for a total of about eight hours. At the Shuttle's orbital speed of seven kilometers per second, the radar could cover ten million square kilometers of the Earth's surface — the area of the United States. The experiment planners spent many hours deciding which parts of the Earth to image and what to do in case of unforeseen changes in *Columbia's* flight plan.

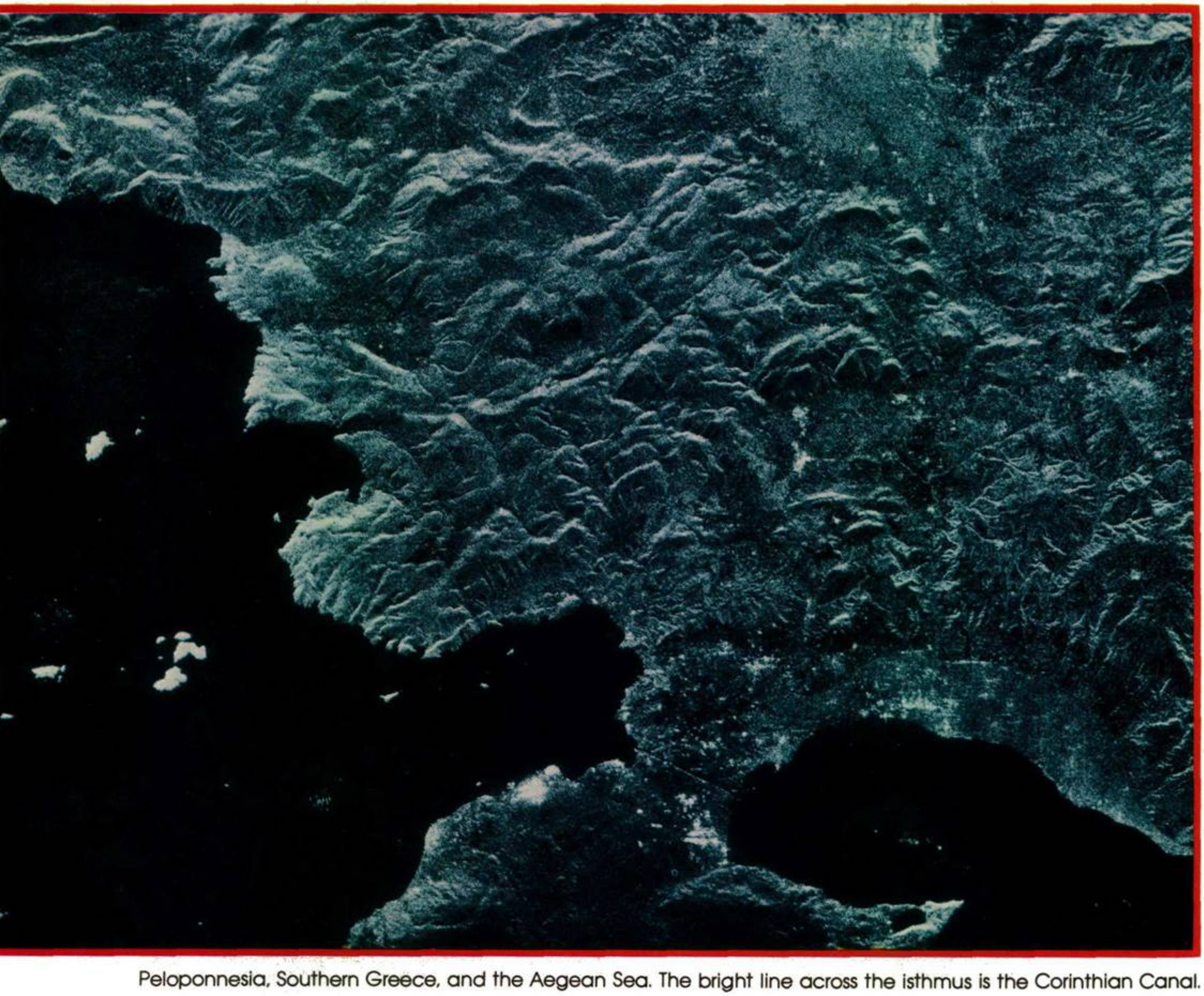
These contingency plans paid off when problems with *Columbia*'s fuel cells shortened the mission from five to two days — and a year of targeting work went out the window. To make matters worse, the Shuttle's orbital altitude was several kilometers higher than that used in the SIR-A planning. Since the radar was pointed 50° away from the nadir, changing the altitude would change the spot on the Earth its beam would strike. Also, a higher orbit meant *Columbia*'s orbital period would be slightly longer, and scientists would have to use a different timing sequence for the radar.

Using a mountain of computer printouts of the Shuttle's orbital track, the experiment team generated and sent up to the spacecraft a continuously updated command list telling the radar when to turn on and off and what settings to use for the various switches and controls.

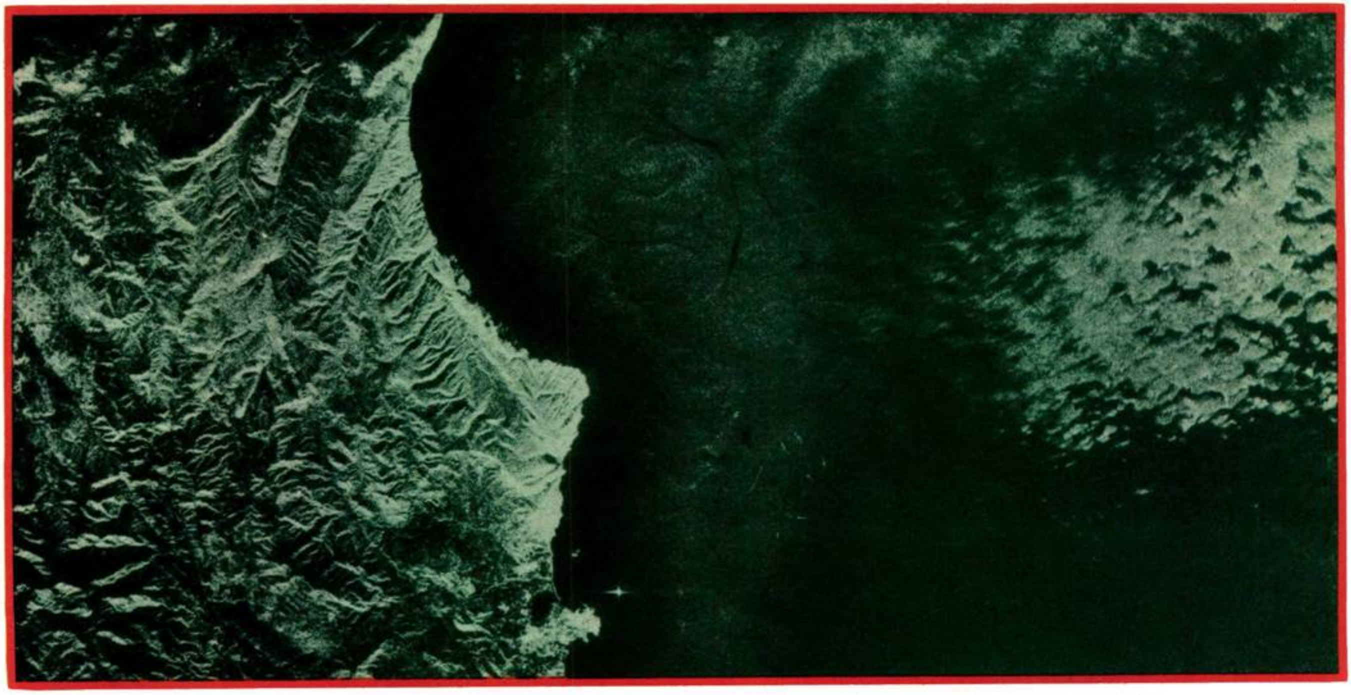




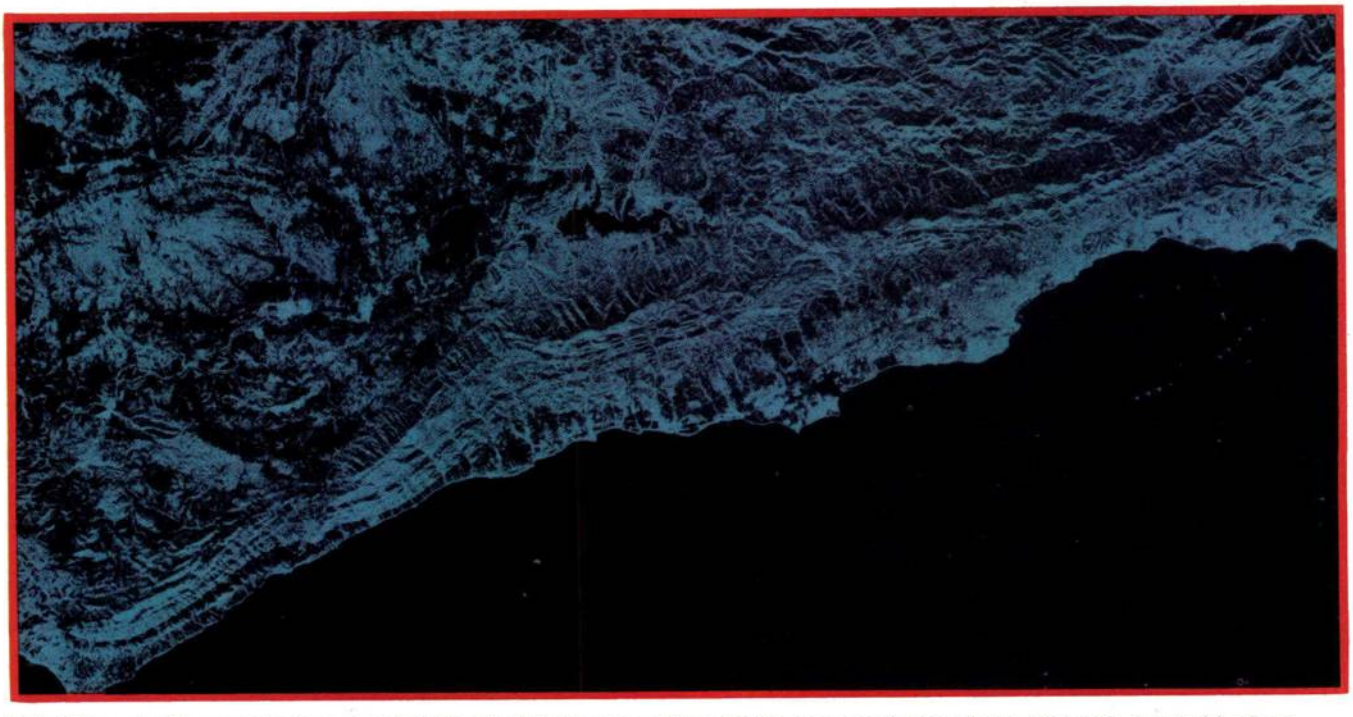
The freeway system of Los Angeles shows as black lines criss-crossing this image of the city and the Los Angeles Basin.



Peloponnesia, Southern Greece, and the Aegean Sea. The bright line across the isthmus is the Corinthian Canal.



The east-central coast of Sardinia and the Mediterranean Sea. The star-like spot off the coast is a ship.



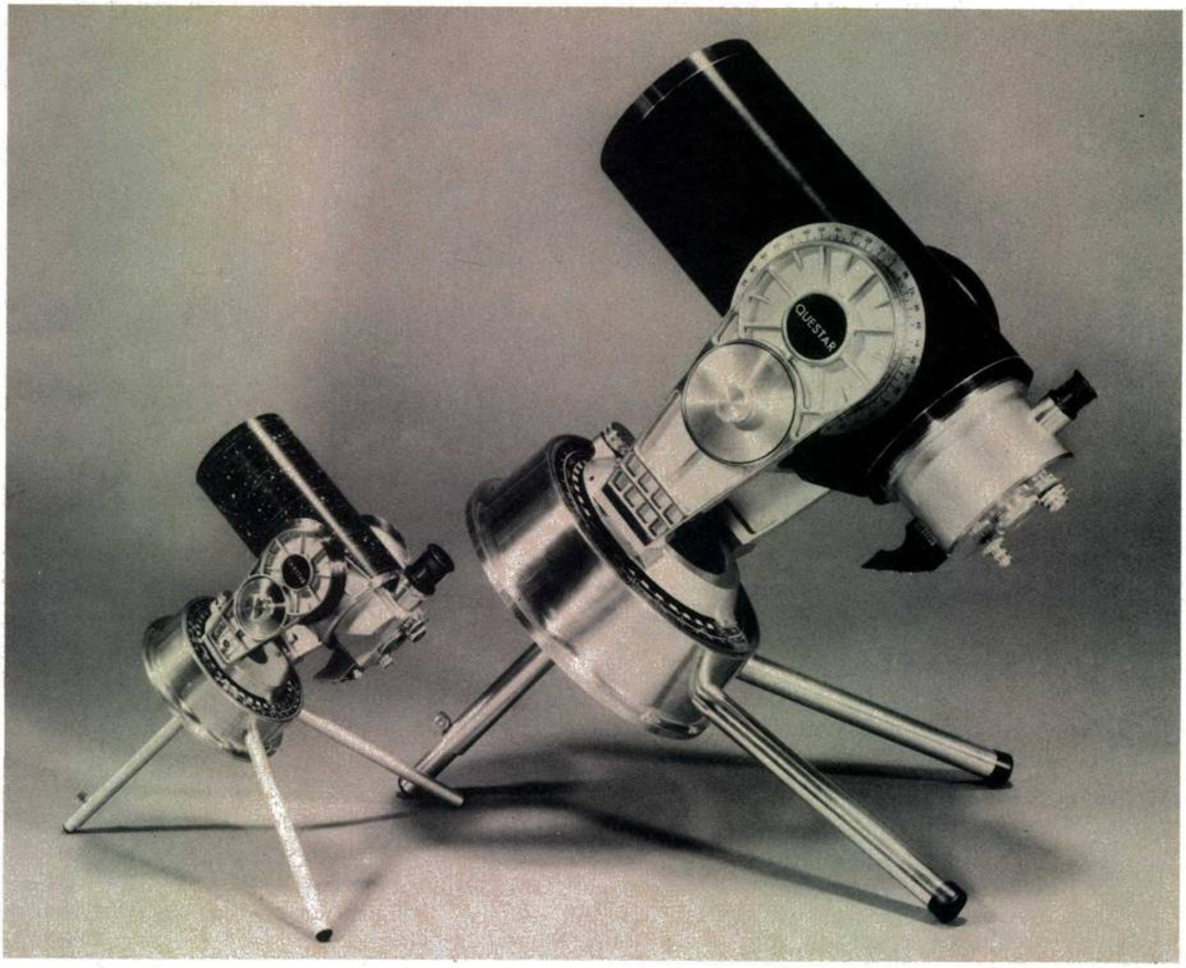
Oil-drilling platforms mimic a constellation in this image of the California coast from Point Concepcion to Ventura.

The result was a near-perfect SIR-A mission. The radar worked extremely well and obtained its projected eight hours of data even though *Columbia*'s time in orbit was 60% shorter than planned. The resolution of the SIR-A images was 37 meters on the ground — better than the designers had expected.

All the scientific results from SIR-A are not in yet. Processing the raw radar echoes into images is a time-consuming operation, and the interpretation of those images takes even longer. The experiment team and others in the scientific community will spend months and even years poring over the images, learning how familiar terrain looks at radar wavelengths and deciding which geologic features most strongly influence a radar image.

The SIR-A experiment proved that the U.S. space program can put highly sensitive instruments in orbit at a lower cost. And what scientists have learned from it will have a great impact on the design of future radar-mapping missions. Shuttle-launched radar has proved its mettle, and could now be dispatched to image any part of our globe — or the other planets of the solar system.

Michael Kobrick's last article for ASTRONOMY, "The Topography of the Terrestrial Planets," appeared in the May 1982 issue. He is a member of JPL's Remote Sensing Team.



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The remarkable Questar drive impresses everyone who uses it. Hubert Entrop, who takes beautiful deep-sky photographs (a number of which we have published here and in our recent issue of QUESTAR OBSERVATIONS), frequently comments on the quality of the drive. He has written us: "The motor drive on the Seven works very smoothly and quite precisely, even though the guiding is being done at twice the focal length of the 3½."

Another time, when sending us some pictures, he said, "The Seven base drive is so smooth that the shutter in the off-axis guider was not used even once for all four of these exposures." And again, "With the Seven there is never any problem in guiding; it no doubt has the best motor drive of any scope outside of observatory equipment."

These comments come from an observer who is using his equipment in all sorts of difficult terrain, on mountains, in the desert, and often under the most adverse weather conditions. In this regard he once wrote us that pictures he was sending to us were taken in winds gusting to 40 m.p.h. He concluded, "So these results are a tribute not only to the optics but also to the Questar design and drive mechanism."

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ASTRONOMY FORUM

The Billion-to-One Chance

It was mid-morning, Tuesday, October 6, 1981. I had just completed my classwork in our cozy planetarium and poured a cup of coffee before starting the grinding machine in our optical shop. The project at hand was completing a series of mirrors of differing diameters but sharing the same focal ratio. The twelve, six and four-inch mirrors were already completed, and the machine was roughing out a ten-inch while I prepared the eight-inch for parabolizing. We waste very little time around here.

The first taste of Mrs. Olson's favorite brew had washed down my gullet when the phone rang. I picked it up and said, "Hello. Astronomy Department." The voice from the past came through rather weakly — it's a long way from Austin, Texas to St. Paul, Minnesota — "Hi there, old man!"

It was Rick Binzel — former student and assistant of mine at Macalester for four years. His work in asteroids and photoelectric astronomy had earned him the third annual American Physical Society's Apker award as outstanding undergraduate physics student in the country. Rick was now in his second year of graduate astronomy work at the University of Texas at Austin, and had spent his summer at Kitt Peak and related big instrument locations. If you suspect that I'm a mite jealous, you're probably right.

"Hey, Doc, I hope the weather is clear up there tonight. You and Lance will have a chance to see an occultation of a star by asteroid 88 Thisbe. You may be on the line according to latest data from David Dunham at the International Occultation Timing Association."

"Give us the details and we'll worry about the weather when it happens. . . ."

"Well, 88 Thisbe is due to occult SAO 187124 at 2:02 U.T. — 9:02 your time. The star is 8.9 magnitude and the asteroid 11.8."

I absorbed the figures. We're located right between two large metropolitan areas, Minneapolis and St. Paul. Why was Rick talking about an 11.8 magnitude asteroid? Had the dark skies he'd worked with all summer made him forget what we struggle through in the upper midwest?

"The position of the star is at 18 hours 37.9 minutes, and declination is -20°33'," Rick continued.

MINUS 20°? From our 45° north latitude, the star would be less than 25° above our southern horizon when on the meridian — and at 9:02 it would be some distance to the west and considerably lower.

All I could manage was "Fine . . .er . . .thanks for the . . . uh . . .info and confidence that we may be able to do anything from here." Fortunately, for the first time in a long time my evening was not planned — at least not until Rick called.

That afternoon I phoned Lance Allred, one of the high school seniors who had worked on the photometer under Rick's guidance. Lance had spent many long, cold winter nights at the telescope. He knew his way around the skies, and had logged all the Messier objects with the 6-inch reflector he made with our help when he was a sophomore. Lance and I agreed to meet at the school office at about 6:30.

First we went into the planetarium to see where SAO 187124 would be around 9:00 local time. What we saw wasn't encouraging; the star would be low. And our observatory has a roll-off roof supported by a concrete block wall about eight feet high. We never worried much before about cutting off the horizon since it was already lost in nearby trees. Now we worried.

Lance went to work with the star charts and located SAO 187124. We unlimbered the 12.5-inch Cassegrain, and in less than three minutes, he had SAO 187124 in the eyepiece.

Ah, young eyes. At 59 years, my right eye's central vision has suffered, and my left is nothing to brag about. But when I pointed the 12.5-inch f/7 Newtonian toward the area, I located the target star without much trouble.

Both instruments peered just over the surrounding walls. Fortunately, we had replaced the old drive motors last summer with stronger models, so the image held steady.

Then, barely louder than the ticking and whine of the WWV time signals, Lance whispered, "I see the asteroid!"

I hurried over to the Cass. With its higher magnification, I saw a faint star not shown on the chart. But maybe the charts didn't go that faint anyway — so we waited. After ten minutes we saw that the span between the star and what had to be 88 Thisbe was shrinking!

Terry Fabian joined us and brought along a pair of stopwatches. We planned to start one watch at 9:00 — two minutes before the predicted occultation. If we were on the path, and the star was occulted, Terry would start the second watch when I stopped the first. Then, when the star came back, he'd turn it off. If everything worked, we'd get the time and duration of the occultation.

9:00: We switched on the tape recorder and started the stopwatch

ASTRONOMY Observer's Page

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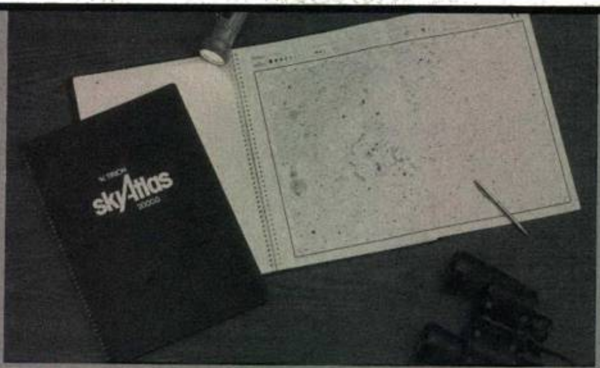

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in sync with the time signals.

9:01: Two anxious people stared into the eyepieces; one held the second stopwatch. The error in the prediction meant it could happen any second now — 9:02:00, :01, :02, :03.

Lance started to say something at 9:02:16 and — BINGO — SAO 187124 left the universe in a wink!

"It's gone." Terry clicked his watch on, and I stopped mine: 9:02:17.

Eternity lasted only 10 seconds. "It's back," we said in unison. Ten and a quarter seconds.

I forgot to look for secondary lapses of light from the star. Lance remembered, but he saw none during the next three minutes of scanning.

Then we looked at each other in total disbelief. The star and asteroid were getting lower. The wall blocked some 15% of the objective area — a loss too small to have mattered, but awfully close.

Lance communicated our success and findings to David Dunham. I wrote to Rick the next day. When he replied, he said that we had joined a rather select group — probably fewer than 50 people — who have witnessed such an event. It was a good feeling after 47 years of astronomical interest.

Later, I began to think of the factors that allowed us to witness such a lineup. The leverage of the very long shadow cone cast into space by 88 Thisbe was the first item. Our measurements helped refine its diameter — some 214 kilometers, about 120 miles. And because SAO 187124 is a point source of light at infinity, its shadow cone has parallel sides. Finally, to reach Earth, the shadow had to extend about 3.5 astronomical units from its position on the far side of its orbit about the Sun.

The entire surface area of the side of Earth facing the Sun intercepts only one part in two billion of the light leaving the Sun. The area of a sphere with a radius of 3.5 AUs would be just over 12 times greater, or only one part in 25 billion of the surface area of that larger sphere. The chance that the shadow cone of 88 Thisbe would fall on Earth is very small indeed.

To top it off, that skinny little shadow is only 120 miles wide on a globe 8,000 miles across, so the chances grow slimmer still. And when you factor in that the part of Earth you are on must also face the event. . . .

Oh yes, the weather must also be clear — and during a fickle Minnesota autumn that's another long shot.

And what are the chances that an adequate telescope, not to mention two, would be located in the shadow path? A pair of side-by-side 12-inch reflectors, properly driven and mounted aren't exactly field equipment! I suppose calling it a billion to one chance is really very optimistic.

—Sherman W. Schultz, Jr.
Lance Allred
Terry Fabian
Macalester College
St.Paul, Minnesota

Stargazers of the World — Unite!

Someone named J. Derral Mulholland recently wrote a letter to *Science News* (January 9, 1982, vol. 121, no. 2) defining "amateur astronomer" as "one who does trivial astronomy in his spare time and with equipment that is not normally suitable for serious research." This resulted in a deluge of letters from irate amateur astronomers who rightly pointed out that amateur and professional astronomy were once equivalent, and that the scientific contributions to astronomy by amateurs were neither trivial (considering the four million high-quality star measurements made annually by the AAVSO), nor made with unsuitable equipment (witness the photometers and computers employed by members of IAPPP and IOTA).

I must admit to being indignant myself about the writer's ignorant definition of "amateur astronomer" — but the responses to his remark failed to point out something that I feel most strongly. People who do not do "serious" observing should not be made to feel inferior by those who do.

It's a sad fact of our pursuit that, just as some "professionals" look down on "amateurs," some amateurs look down on "stargazers." Yet astronomy, as a hobby, should make the hobbyist happy and enrich his or her life. Astronomy has enough breadth to accommodate all levels of interest and many kinds of enthusiasts.

If you like achaeology, you can go to Stonehenge and the medicine circles. Geology your bag? Scrutinize meteorites and ancient craters. Mythology? Study the constellations. History? Look back to Tycho or just as far as Barnard. Do you have a philosophical mien? Ponder the meaning of it all and the ideas of cosmology. Enjoy the exotic? Read about black holes and neutron stars. Love the outdoors? Just stargaze with the naked eye or binoculars and become sensitive to the movements of the sky with the seasons and follow the movements of solar system bodies. Are you into photography? Try to outdo the big observatories. Love to travel and meet people? Go to the numerous amateur conventions and meetings.

About the only thing I thought you couldn't do with astronomy was open a booth in a flea market and sell it. But I was wrong about that: I hear someone was at the Circle Drive-In selling views of the Sun, properly filtered, for a quarter a look.

Variety in life should not be discouraged or merely tolerated; it should be cherished. You may want to make a contribution to astronomy via the AAVSO or IOTA, but you shouldn't feel you have to. And you shouldn't be made to feel guilty if you don't.

Curiously, it's only in astronomy that I've found this attitude. Most rockhounds I know aren't trying to identify new varieties of minerals; most birders I know don't pretend to be ornithologists. Hikers and backpackers don't labor under the illusion that they must explore new lands.

What makes this supercilious attitude toward "non-serious" observers so hard to understand is the nature of astronomy as a hobby. I can see where professional paleontologists or archaeologists might have a gripe if a rare find were hacked up and destroyed by thoughtless, careless, or ignorant beginners. But the sky isn't harmed by a casual glance. Stars do not get worn out by the people who are just looking for pleasure. Galaxies aren't erased by too many people looking them over, even with slightly out-of-focus or out-of-alignment equipment. So why should anyone criticize the casual stargazer?

So stand up for your right to enjoy your hobby as you choose and to grow in it at your own pace. Remind yourself that most people are attracted to astronomy by the mystery and beauty of the night sky, not by any affinity for physics and technology. Remember that even the most serious observer is likely moved by the glory of the heavens. consider this excerpt from a 1967 *Life* magazine article by Loudon Wainwright about George Alcock's discovery of Nova Delphini 1967:

"When asked why he spends so much time looking at the stars, Alcock was not able to provide

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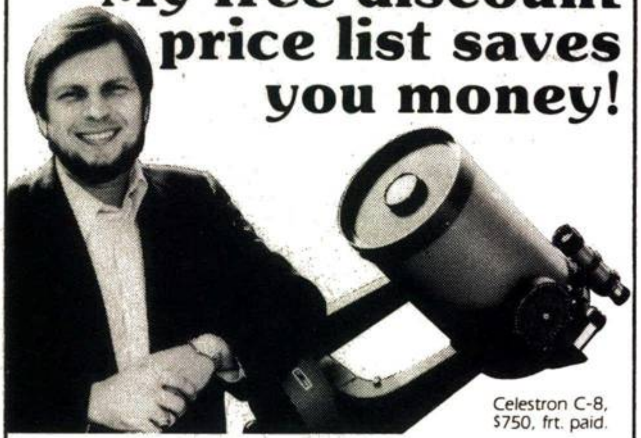

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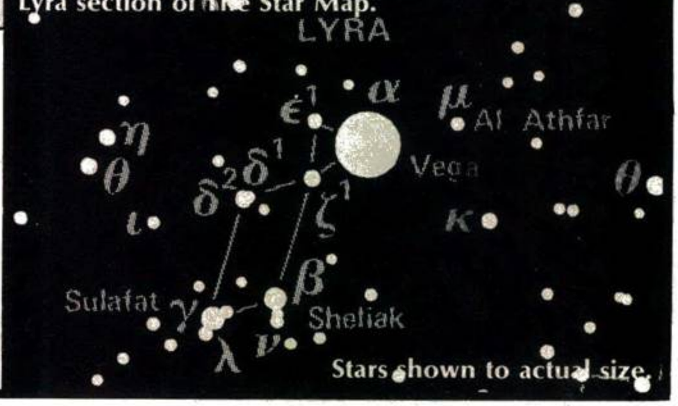
Lyra section of The Star Map.



Stars shown to actual size.

much in the way of self-illumination. A direct and active man, he is uncomfortable with introspection and seems embarrassed with a search for reasons. 'It's not a boring thing at all,' he told me. 'It's beautiful, the dark sky.' Then he added: 'The stars shine like jewels in the binoculars.' In a sudden burst of laughter he went on: 'And I'll keep looking.' he said. 'No man has ever found two of these by visual search.'

"Perhaps the best answer is found in his own logbook. The neat, steady handwriting as he recorded the time and place of the nova's appearance does not convey the excitement he must have felt at the time. Yet a little further on he added another sentence, and it gave him away. 'The star was recognized at once as a stranger,' he wrote, and even for fools who never look up until the rain strikes their faces, these simple words carry with them something of the tremendous surge of joy Alcock knew in this rare meeting of man and another world in the the night sky."

Jo-Ann Pluciennik
Scranton, Pennsylvania

— from "Ecliptic" — the newsletter of the Lackawanna Astronomical Society.

The Science Illiterates

Bad stars. If 1981 was the year of the Arkansas creation *vs.* evolution trial, then 1982 is the year of dis*aster.* You probably heard the claim that the planets would position themselves in a straight line out from the Sun in 1982 — the heavenly sign that the Bible prophesied would accompany the end of the world. The alignment would foretell major devastating earthquakes and who knows what else. Sadly, many people were genuinely worried.

About the alleged planetary line-up: they didn't, folks. But the accompanying nonsense underscores a disturbing trend in America, a rise of irrationalism spun off the decrease in science and math education. Recent, well-publicized studies show that American students lack education in science and mathematics. A headline in the *Denver Post* recently asked, "Are U.S. Schools Turning Out Scientific Illiterates?"

I believe the answer is yes. The contrast between American education and education in other nations can be outright embarrassing. Example: All Russian students receive five years of biology. Only one-half of American students receive as much as one year — and "creationists" want to dilute even that small amount with religious dogma.

In physics, the comparison is worse. All Russian students graduate with five years under their belts. American students? One year — for the 9% who care to take it. Stress on science education has decreased greatly since the years following the launch of Sputnik — an event which shocked the western world.

Science can be described, in oversimplified terms, as an enormously successful logical method for studying reality in all its aspects. If we encourage the people of our nation to ignore a rational understanding of reality, then what choice have they but to turn to irrationality?

Many people educate themselves, certainly. But I've personally dealt with too many intelligent, curious people who, without the firm guidance and discipline that a long formal education provides, wandered off into the wild blue yonder. One can become lost all too easily on a self-guided tour of the unknown.

But what do we see when looking over the American scene? A man in Little Rock states publicly that he believes UFOs are manifestations of Satan. A desperate, misguided group in Tucson sells their personal belongings to advertise the date of something called "rapture," when all the truly good people will float bodily to the heavens above (or somewhere) — leaving the rest of us behind. This group gave up after failing its second predicted date.

Astrologers outnumber Astronomers roughly ten to one . . .

Astrologers outnumber astronomers roughly ten to one. I can understand why — the cosmos appeals to us all — but asking "What's in it for me?" may send an uninformed person to an astrologer before going to an astronomer — or a psychiatrist.

And, most insidiously, scientific illiterates distort, omit, and reject outright virtually all that mankind has learned throughout history. They retreat to an infantile world view based upon a literal reading of the best known of the many creation accounts from around the world.

It was no surprise that two alleged astronomers came out with a bad theory and published it in a paperback book called *The Jupiter Effect.* Nonsense is published all the time. They proclaimed major earthquakes would follow a great line-up of all the planets in 1982. But our nation's response was so off-the-wall and widespread that one of the originators, in retracting major points of the theory, expressed shock and dismay.

Can this be dismissed as an intellectual problem of little consequence? No, a thousand times, no! Can we forget that education is the backbone of democracy? How can a scientifically illiterate public vote on technological issues? How can we maintain a sound economy without a firm foundation of science and technology?

At a local level, we starve our school systems. In Washington, we hear the Reagan Administration state that "The President recognizes the value of science and technology, but . . ." as it proceeds to slash our educational investment in the future, "economic recovery is his first priority." The Administration has gone out of its way to destroy the science education efforts of the National Science Foundation.

Meanwhile, Japan, with a far more rigorous — perhaps even too rigorous — educational system, continues to train five times more engineers per capita, and churns out televisions, radios, stereo systems, cameras, and automobiles for export to America, as well. If we don't get our science act together, someone else will. We aren't launching a mission to the most famous comet of all, Halley's, soon returning for a once-in-a-lifetime visit. We'll pick our noses while Russian, Japanese and western European spacecraft fly past for close looks.

This is the American Scene, 1982, with its great planetary line-up. Astrologers had a field day. Does it matter to anyone that the planets didn't actually line up? The planets did group together, somewhat, but there were no physical consequences since the forces between the planets approach zilch.

There will be major earthquakes, quite possibly in California, but there are dozens of minor quakes every year and over a dozen great ones. And, who knows, the world *may* end in 1982 — but the reason for the ultimate disaster will have nothing to do with planets: it lies much closer to home.

Gary Mechler
Tucson, Arizona

Gary Mechler, a child of the Sputnik era, holds a Ph.D. in astronomy and works as public information officer for a major research center in Tucson.

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eye on the sky

moon pales perseids

by Fred Schaaf

the wanderers

Summer's last full month heralds the closing of a night sky filled with prominent planets. But it also brings us the famous Perseid meteor shower and a Mars/Jupiter waltz among the summer stars.

Mars' and **Jupiter's** best conjunction occurs August 9 when the two planets pass just 2° 5′ of each other. On that night Mars will shine at magnitude +0.8 and Jupiter -1.5. This is the last great conjunction of these two planets until 2123 A.D.

After this year's conjunction, Mars races to cross into Libra at mid-month and is south of Alpha Librae by the end of August. Jupiter creeps near Lambda Virginis up to the Virgo-Libra border by month's end.

The third bright planet in Virgo is **Saturn**. Moving more slowly than Jupiter and Mars, Saturn is westernmost of the three, and sets first in evening twilight. The Ringed Planet passes close to Theta Virginis, and will shine with almost the same brightness as nearby Spica.

On August 10, Saturn is at its faintest for the year — though it's not farthest from Earth until October. On August 27 it is at its greatest latitude north of the ecliptic — an event that takes place once every 29 years.

Low in the west, **Mercury** drifts closer to an unfavorable greatest elongation. On the eve of August 7, when the innermost planet passes 1° 1′ north of Regulus, it will be difficult to find low in the bright twilight, just a speck at 0.6 magnitude. On the 30th Mercury reaches aphelion.

The last bright planet is only 20° from the Sun on the morning of the 20th when it glides through the northern part of M-44, in Cancer. **Venus** is dimmest this month, though still extremely brilliant, glowing at magnitude -3.3 on August 6. Its decreasing size is offset by its increasing phase, so you'll notice a slight brightening.

An asteroid makes our list of objects for the naked eye this month — in dark skies at least. Bright **Vesta** is closest on August 5, brightest on the 3rd, and at opposition on the 10th— less than a degree from both Zeta and 36 Capricorni.

August's main event is a meteor shower. The last quarter Moon will seriously interfere on the morning of the 12th, when the **Perseids** are at peak activity. This shower's members have been numerous in recent years due to the approach of their parent comet, Swift-Tuttle. Although there haven't been a lot of fireballs in the past few years, the hourly counts have been high — 100 or more. If you're far from city lights early on the 12th, you may see a good show of these swift meteors from the north, despite the Moon. And there's always the chance that the Perseids will pour down in the colossal numbers of a true meteor shower.

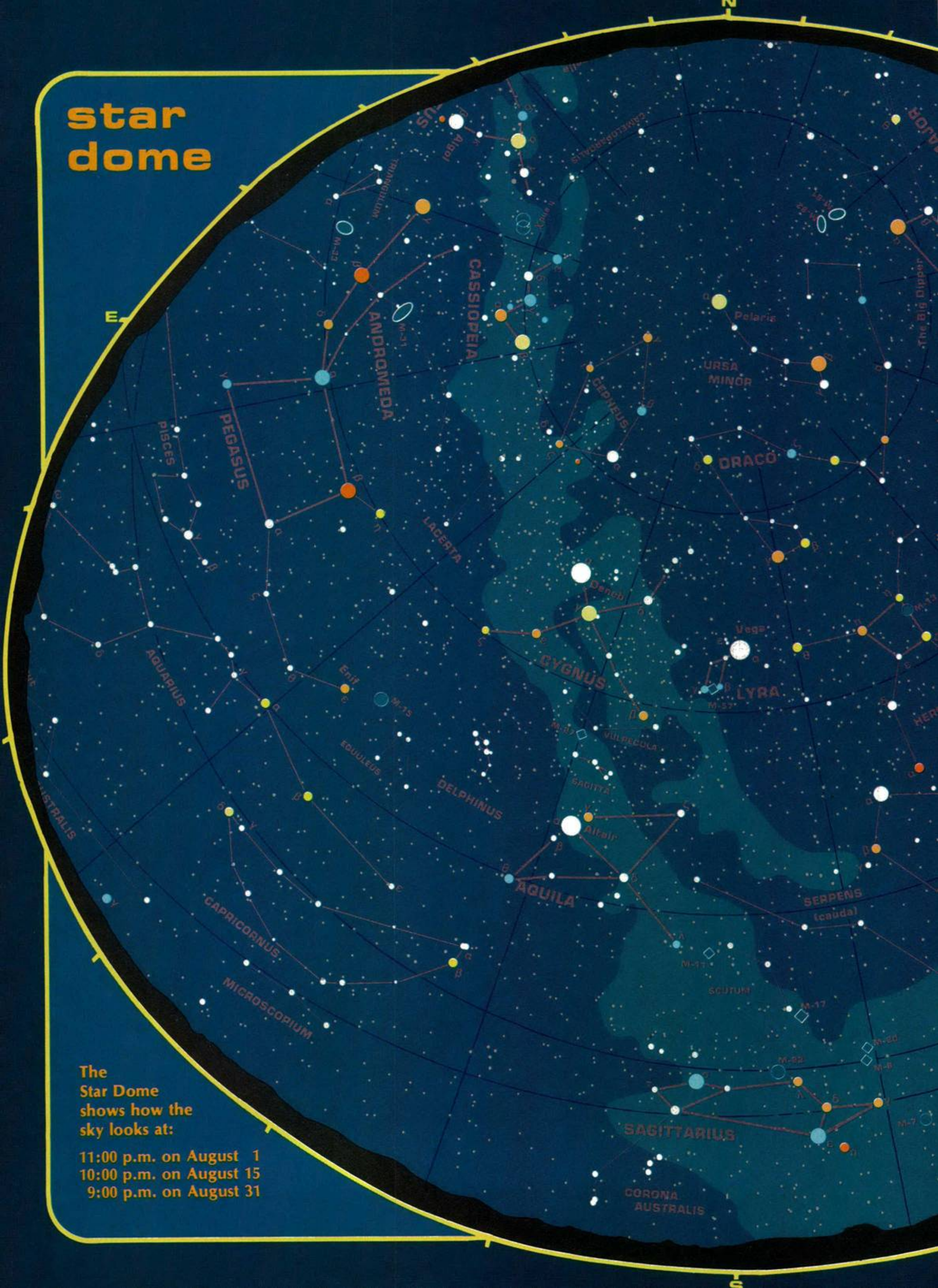
the starry sky

Giant Scorpius climbed part way out of the stream of soft radiance we call the summer Milky Way, and will be poised on the zodiac for thousands of years longer.

The stinger of **Scorpius** is bright, but so far south that it grazes the horizon even in southernmost Canada. Its most brilliant luminary is Lambda Scorpii, also called Shaula, only 35′ from 2.7 magnitude Upsilon (Lesath). Twice as

For this late-night photo of Orion rising (right), Nelson Chow used a 30-second exposure on Ektachrome 400 through a 50mm f/1.4 lens. Left: the Lagoon Nebula is a prominent misty cloud low on the southwestern horizon and above the spout of the Teapot. Paul Roques used an 8-inch Schmidt-Cassegrain and a 20-minute exposure on hypered 2415 film for this portrait.

star dome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Algol
TRIANGULUM
M-33
M-31
ANDROMEDA
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Double Cluster
Polaris
URSA MINOR
The Big Dipper
URSA MAJOR
M-81
M-82
CEPHEUS
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VULPECULA
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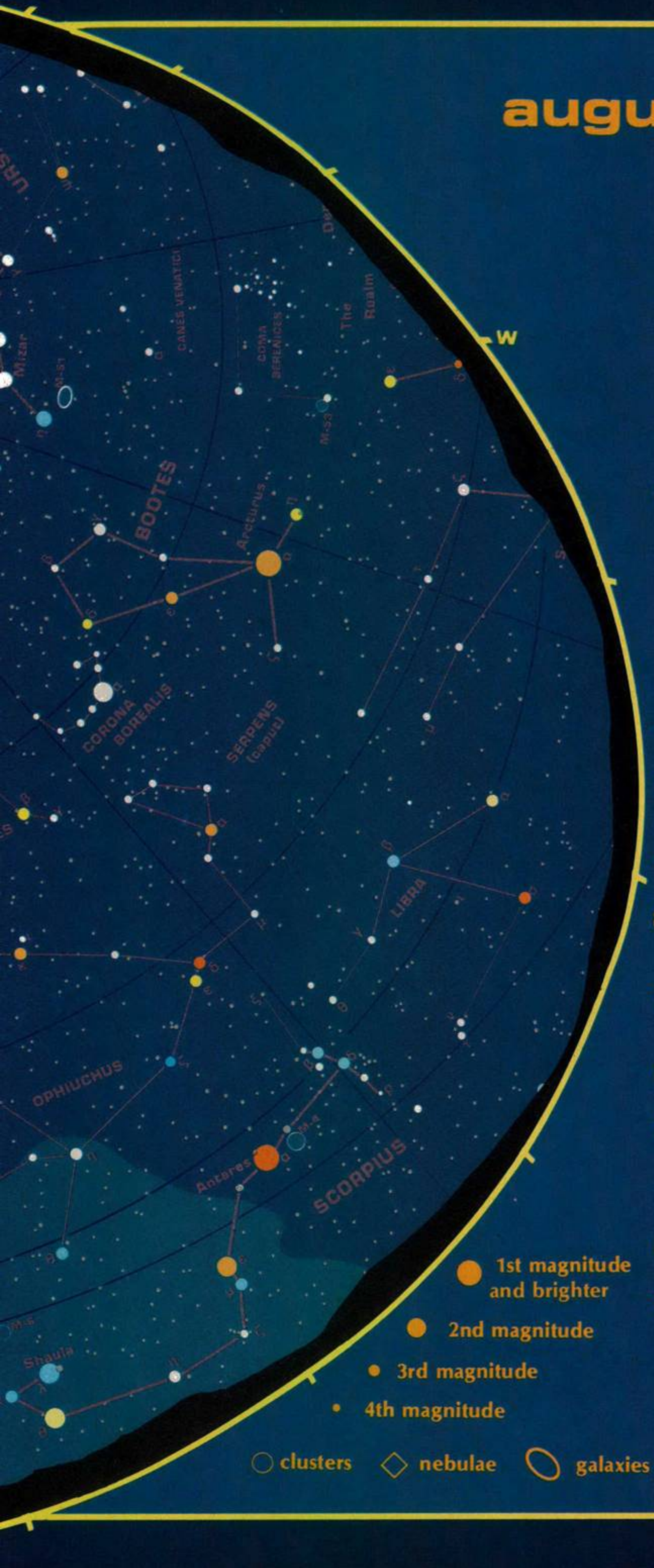
SAGITTA
Altair
AQUILA
SERPENS (cauda)
M-11
SCUTUM
M-17
M-20
M-8
M-22
M-7
CAPRICORNUS
MICROSCOPIUM
PISCIS AUSTRALIS
SAGITTARIUS
CORONA AUSTRALIS

The Star Dome shows how the sky looks at:

11:00 p.m. on August 1
10:00 p.m. on August 15
9:00 p.m. on August 31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CORONA BOREALIS
SERPENS (Caput)
LIBRA
OPHIUCHUS
M-4
Antares
SCORPIUS
M-6
Shaula
● 1st magnitude and brighter
● 2nd magnitude
● 3rd magnitude
● 4th magnitude
○ clusters
◇ nebulae
○ galaxies

august sky almanac

1st	The Moon is at apogee this morning: 251,934 miles.
4th	Full Moon is at 6:34 p.m. EDT.
9th	Tonight, Mars will be poised to overtake Jupiter, 2.3° south of it. Jupiter is bright and white; Mars is dimmer and orangish.
12th	The Perseid meteor shower peaks during daylight hours today. The best times to watch are during the predawn hours today and the same time tomorrow. Unfortunately, the light of the Moon, which is at Last Quarter at 7:08 a.m. EDT, will wash out the fainter Perseids.
16th	The Moon is at perigee late tonight: 225,272 miles.
17th	In the predawn sky, look for a very thin crescent Moon near Venus.
18th	The Moon is New at 10:45 p.m. EDT.
22nd	Saturn and the crescent Moon are nicely paired in the evening sky.
24th	By tonight, the Moon will have moved on to the east of Mars and Jupiter.
26th	First Quarter Moon is at 5:49 a.m. EDT.
27th	Sharp-eyed observers may be able to spot Mercury very low in the west right after sunset, but this evening apparition is the year's worst.
28th	The Moon is at apogee tonight: 251,438 miles.
30th	Mercury is at aphelion.

Refraction makes autumn's Harvest Moon appear closer to Earth than it is and also intensifies its color. Mark Baespflug captured this photo with a 1-second exposure through an 8-inch Schmidt-Cassegrain on ASA 64 film as our satellite rose over the Cascade Mountains near Puyallup, Washington.

wide as this separation is the fine cluster near the stinger, **M-7**. Ptolemy recorded both M-7 and the cluster north of it, **M-6**, 2,000 years ago. Even if your skies are not perfectly dark, you can spot M-7 with your naked eye.

Shaula is one of the bright stars nearest to the galactic nucleus in Sagittarius. Another star, Beta Tauri, or El Nath, has a strange relationship with Shaula. These two stars lie at nearly identical distances from us — one toward the Milky Way center, the other directly opposite that point — and shine at nearly identical brightness. Shaula's apparent magnitude of 1.62 and distance of 300 light-years is similar to El Nath's magnitude of 1.65 and 310 light-year distance. Both have a luminosity 1700 times that of the Sun. It seems that we ride around the galaxy with a bull's horn and a scorpion's stinger at either shoulder.

Remember that these stars, and clusters like M-6 and M-7, are foreground objects compared to the hidden galactic center — 33,000 light-years away. We can see far enough through the vast distance of interstellar dust to behold the edges of the center: the millions of stars that gather together to form the **Sagittarius Star Cloud**. This prominent patch of Milky Way radiance lies near Gamma Sagittarii — the star that forms the tip of the spout on the famous **Teapot** asterism.

The Teapot stars are bright, but not all that meets the eye here is a star. You can glimpse several star clouds, at least one nebula, and a globular cluster without optical aid. The smaller cluster in the Cloud is the bright knot of luminosity (about 2° by 1°) above the Teapot. A few degrees above Gamma Sagittarii is M-8, the **Lagoon Nebula**, smaller and dimmer but detectable with unaided vision under good conditions.

Binoculars will improve your view of

many objects in Sagittarius, but the overall naked-eye sight of the region far from city lights is better. Include a view of the Sagittarius Milky Way on your summer vacation.

Farther up the Milky Way from the Archer is the **Scutum Star Cloud** in Scutum the shield. In the midst of the Cloud is 6th magnitude **M-11**, one of the finest open clusters in the sky. Just west of Scutum you'll see the beginning of a dark split in the Milky Way. This is the **Great Rift**, formed by massive dust lanes in the galactic equator. You'll also notice **Serpens Cauda**, the serpent's tail — a line of stars extending from **Ophiuchus** the serpent-bearer.

Northward along the Milky Way band you'll see **Aquila** the eagle, featuring **Altair**, the second brightest of the summer stars, and one of our closest neighbors. Altair is not much larger than the Sun, but rotates more rapidly than any other bright star. Its huge bulk spins around once every 6½ hours!

Among other stars in Aquila is the naked-eye variable **Eta Aquilae**, located in the eagle's southern wing. This star is a Cepheid variable, and rises from magnitude 4.5 to 3.7 in two days and then back to minimum in five. Aquila also contains a brilliant nova that flared to the equal of Sirius in 1918.

Near the zenith during August is the "arc-light" of the sky, blue **Vega**. Its tiny constellation, Lyra the lyre, harbors many targets. Use your naked eye on a steady night to split Epsilon Lyrae, the famous "Double Double" to the northeast of Vega. Naked-eye variables in Lyra include the mysterious Beta and the semi-regular R Lyrae that fluctuates between 4th and 5th magnitude in a 46-day period. The companion of Vega and Altair in the Summer Triangle is **Deneb** in Cygnus the swan.

skylore

The constellation Sagitta the arrow has only two stars brighter than 4th magnitude, and only four brighter than 5th, so its location and attractive, compact shape must have been factors in its recognition by classical astronomers. Among the ancient Greeks, Aratos acknowledged the beauty of Sagitta by calling it "the feathered arrow" and "the well-shaped dart." The names arrow, weapon, or dart symbolize the reed that arrow shafts were made from.

The Hebrews, Armenians, Persians and Arabs also referred to Sagitta as the Arrow. The Arabs called it Al Hams or Hamsah, the Five — the fifth most prominent star in Sagitta extends the shaft beyond 3.5 magnitude Gamma Sagittae. Julius Schiller turned Sagitta into the Spear of Longinus or the Nail of the Crucifixion.

Only one star in Sagitta has a name: 4.4 magnitude Alpha Sagittae is called Sham. R.H. Allen says that Piazzi called the whole constellation Sham, from the Arabic Al Sham, the arrow.

The story of the Arrow is a heavenly whodunit. Who shot the Arrow? What was it aimed at? Why was it shot?

One answer to the first query is the Archer of the heavens, Sagittarius, a fellow occupant in the summer sky. But the positioning is all wrong. The Archer always faces west with a drawn arrow pointing at Scorpius. Sagitta is well above and behind him, flying in the opposite direction.

Some interpreters of the sky suggest that no one shot the Arrow; instead Aquila carries it through the starry realms in his talons. Northerners might picture Aquila as banking and almost inverted to hold the more northerly Arrow.

Others say Hercules launched Sagitta from a bow in his battle with the Stymphalian birds. These birds, which plagued the march of Stymphalus in Arcadia, had beaks, claws and even wings made of brass or iron, and devoured the flesh of men and beasts. They blotted out the Sun; their excrement poisoned crops.

Hercules terrified the birds with the clash of great brass cymbals, and then fired his arrows into the deadly flocks. Sagitta is the starry representative of these arrows.

Robert Graves suggests that these birds were from Arabia and that they were "the size of cranes, and closely resemble ibises, except that their beaks pierce a metal breast-plate, and are not hooked." He claims that in the Arabian desert they "cause more trouble than even lions or leopards by flying at travellers' breasts and transfixing them." Where are the Stymphalian birds located in the sky?

They are none other than Cygnus, Aquila, and Lyra. The last may surprise you, but Lyra is often pictured as a bird — a Swooping Vulture to distinguish it from Aquila the Flying Vulture.

R.H. Allen implies that the identification of these constellations with Stymphalian birds was a fancy of the 18th century French astronomical writer Charles Dupuis. If you examine the patterns closely, you'll see Hercules kneeling like an archer, his starry arms arranged just as if he were following through on a shot. Sagitta seems to have passed the height of its arc and might have just missed a wing of the wheeling southern bird, Aquila.

Examine this scene for yourself — on a star chart and in the sky. Other ancient solutions to the mystery of the Arrow include the suggestions that it slew Jove's eagle or was the arrow of Cupid. According to Eratosthenes, Sagitta was the arrow that Apollo used to kill the Cyclopes. These are just a few stories to ponder as you watch the endless, graceful flight of Sagitta — the arrow of the heavens.

ASTRONOMY
IN FOCUS

Tough Women

Sir / Ken Fulton's "Amateur Astronomy: Tough Talk" was one of the best articles I've ever read. I've been an astronomy buff and telescope owner for 18 of my 23 years, and I've had more than my share of clumsy friends, frigid temperatures and clouds that appear out of nowhere.

Far more disturbing, however, is the deterioration of our space program highlighted in the May ASTRONOMY. In an age when mankind has reached farther than ever before, it is heartbreaking to see our newly outstretched arms shackled by budget cuts. It's a shame that those in government are as shortsighted as our ancestors who thought it was lunacy to sail out into the ocean. This country is indebted to those who refuse to believe there are no new frontiers to conquer. And it is about time that we respect, and fund, the Columbuses of our day.

Linda Zimmermann
Nanuet, NY

Sir / Like Ken Fulton ("Amateur Astronomy: Tough Talk," May 1982), I am also proud to call myself an amateur astronomer. Although his article was written in terms of male astronomers, as a woman I could very easily reverse the situations — especially with respect to my long-suffering and patient husband. He is the one who lugs my heavy equipment to the precise location I must have and then, hours later, lugs it back again. He also serves as technical consultant when math calculations are beyond my high-school algebra.

Another "tough" aspect of amateur astronomy is the attitude which a serious woman astronomer must contend with. I remember a salesman who, when I asked for a copy of *Norton's Star Atlas*, smiled sweetly and said, "I am sure that is NOT what you have in mind. It is really QUITE detailed and difficult to understand — or is this for your husband?" Since I had my teen-age sons with me, I did not let the expletives on the tip of my tongue escape. I simply told him that the star atlas was for me and walked out. I have vowed to purchase my *Norton's* by mail and use only my initials on the order.

Mr. Fulton's admonition to learn patience with yourself and your equipment is the most valuable astronomical advice I have ever read. After five years of observing, I am just now beginning to "see" the wondrous things that my modest 6-inch Newtonian can show me. Each time I locate some dim elusive object, the thrill of discovery is new and exciting. And it took time to learn to "see" as well as locate the treasures in my log.

Again, I tip my warm-wooly cap to Ken Fulton for a realistic and engaging piece on the amateur astronomer.

Kay Schumacher
Garden Grove, CA

Sir / As the wife of an amateur astronomer, I would like to say one thing about Ken Fulton's article "Amateur Astronomy: Tough Talk" — I thought it was great! It was as if it were written about my own husband! And though I feel I've always had an open mind about my husband's love of astronomy, I now feel I understand him better. It's not just a hobby — it's an important part of him.

Vickie Kujanpaa
Geneva, OH

Simplified Stargazing

Sir / Like many other amateur astronomers, I found myself in too deep at one time. I started with a slight knowledge of the heavens and a 4¼-inch telescope. The scope exhilarated me but all I could think about during the four months in which I owned it was "more aperture."

I found myself being buried by star charts, books, and an assortment of telescopic accessories. I would not admit I was being pulled too deep too fast and I went ahead and purchased an 8-inch Newtonian. At first, I really enjoyed this instrument but soon I found my interest dwindling. I found it bothersome to lug out its 50-pound mount.

Clear nights have been rare this winter, so when I found myself inside on a few good observing nights something ate at me. I just couldn't get out of my mind what a waste I was making of perfectly clear skies.

I finally found a pleasant relief from the frustration. I set aside at least one night a week to step into my backyard and enjoy the night sky with a pair of binoculars and an ASTRONOMY star map. These simple observations helped me learn some of the more basic parts of observing I had disregarded and gave me the boost I needed to rekindle my interest.

Jed Brewer
Moroni, UT

Columbia in Polar Orbit?

Sir / At 4:34 a.m. EST on March 27, while searching for the globular cluster M-56 in Lyra, I observed a rather bright satellite moving on a straight north-to-south trajectory. It was easy to follow until it disappeared behind a house. Compared to other satellites I've seen, its brightness leads me to believe that I saw the space shuttle *Columbia*, which was in orbit at the time. Am I right?

Michael Coren
Dresher, PA

— *Columbia was launched into an orbit that had an inclination to the equator of about 40°. You describe a satellite moving in a north/south direction which indicates it had essentially a polar orbit. It was probably a military reconnaissance satellite.*

Scanning the Shuttle

Sir / During STS-3, at a frequency of 146.49 MHz, I listened in on the astronauts preparing to alter the ship's attitude and orbital height, and rehearsing a video recording on how they brush their teeth! Not all of what you hear while monitoring the Shuttle/Houston transmissions is a big deal, but the eavesdropping can be a real thrill.

I made the initial reception with a Bearcat 300 programmable scanning radio receiver and the 18″ whip antenna supplied with it. Then I listened in with my portable scanner, which has a 6″ flexible whip antenna. You don't need the same radio receiver I have — just the ability to receive the 146.49 MHz frequency in the 2-meter amateur band of the radio spectrum — or in the VHF/HI band on scanners.

David E. Browning
San Diego, CA

Supernova Searches

Sir / I enjoyed Michael Witkoski's "Searching for Supernovae" in the April issue, but I would like to point out that NGC-6946 has had five supernovae in the last 65 years, not six. A report made in 1969 was based on just one observation which, according to the first supplement to the *General Catalog of Variable Stars*, was probably of a slow-moving asteroid, not a supernova.

Witkoski correctly says that spiral galaxies are more likely to harbor supernovae than any other type, but of all the spirals in the sky, the Sc types offer the best chances. For example, the Sc galaxies M-100, M-83, M-101, and NGC-6946 have had three or more supernovae each since the turn of the century. By contrast, M-31, an Sb galaxy, has displayed only three. None were in this century, and of the three on record, the 1664 event is doubtful.

C.E. Spratt
Victoria, B.C.

Over the Next Hill

Sir / After reading Van Kane's "The Planets or Bust" in the May '82 ASTRONOMY, I realized how important interplanetary space missions are.

What a tremendous morale booster it is to breathlessly watch the radioed images come in from the Voyagers, of Jupiter and Saturn (and soon Uranus), and see worlds completely different from our own. Or to see the Space Shuttle climb majestically into the sky or watch it come out of orbit to land on the Earth's surface.

Arthur C. Clarke said in his book *The Promise of Space*, published in 1968, "The desire to reach the planets is only an extension of the desire to see what is over the next hill . . . ."

Instead of turning our backs on the planets and what they hold in store for us, we should continue to further our knowledge of them. We should continue to climb over the great barriers — the hills of space.

Andrew Grutza
South Milwaukee, WI

Tune In On Voyager

Sirs / With the interest amateur astronomers have in radio astronomy and home computers, why would NASA turn off our space probes? If NASA published the radio frequencies, data from space would not be lost forever. With a proper receiver and a home computer program, anyone could listen and interpret the information. Maybe ESA would guide it for us since our government is unwilling.

D.M. Stoutsenberger
St. George, UT

— *Unfortunately, the signals from Voyager would be far too weak for amateur receivers to pick up — that's why NASA uses 210-foot dish antennas with ultrasensitive master receivers.*

behind the scenes

from newsstand to infinity

With this August issue, ASTRONOMY begins its tenth year of publication. That's right, nine years of ASTRONOMY — 108 issues — now lie behind us. So it's a considerable pleasure to tell you that we're getting ready for another phase in our growth.

Beginning next month, with our September issue, you'll be seeing ASTRONOMY broadly distributed to newsstands. Although we're sold at about 1,000 outlets now, our newsstand distributor will be placing ASTRONOMY on thousands more all across the country — locations where we've never before been sold.

What does it mean to you, a loyal subscriber? It means that your non-astronomical friends will see ASTRONOMY somewhere besides your home — so they might buy a copy and start asking you a few things. It means that people who never thought of astronomy as a hobby will see ASTRONOMY, and perhaps after flipping through it discover they want to know more about outer space. It means, over a period of years, that the general public may become a little more aware of astronomy, that your local astronomy club's star parties will be a little better attended, and humanity will be a little happier for it.

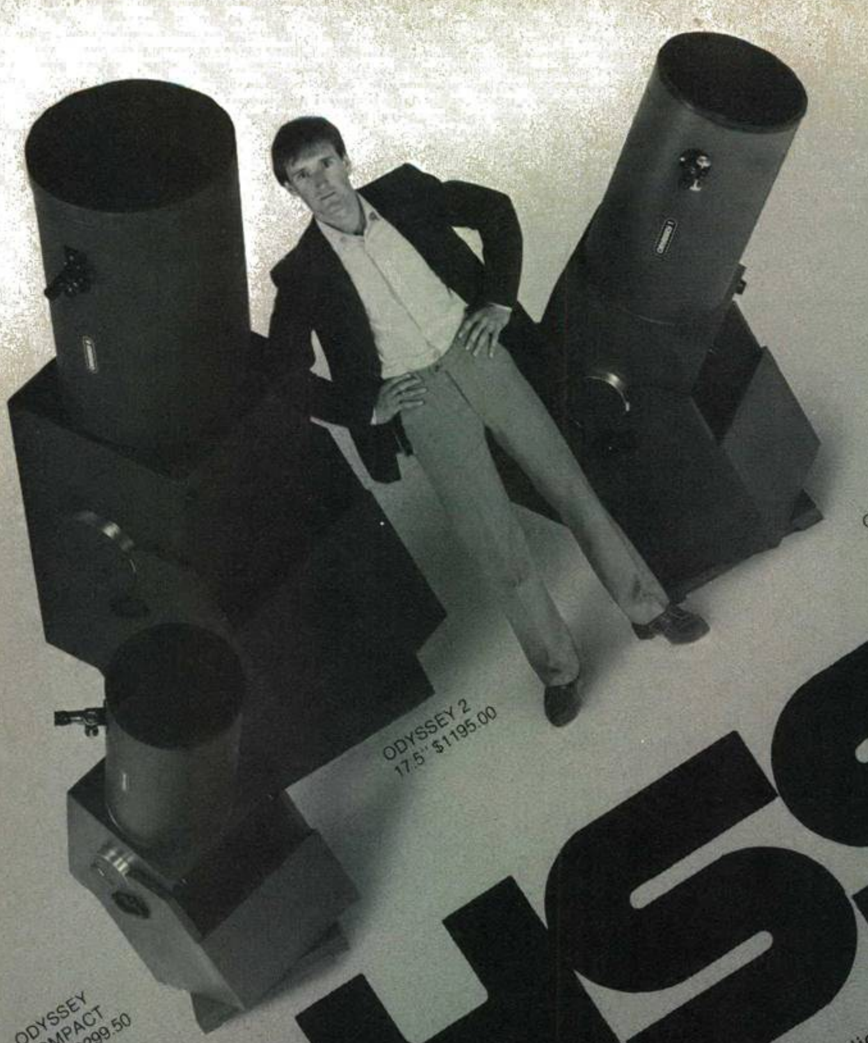
I happen to think that stargazing is good for human beings. It widens horizons, opens up thinking, exposes minds to the beauty and grandeur of the Universe. Sometimes it's only a question of letting someone know that he or she can look into the night sky and learn the stars. Other times ASTRONOMY stirs memories of a long forgotten Cub Scout merit badge — and before you know it, the astronomy bug has bitten another person.

So I'm hopeful: hopeful that people will see our magazine among the hundreds of other offerings, and hopeful that a few will reach out and discover the stars through us.

Sincerely,

Richard Berry

Richard Berry
Editor



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photographing the home galaxy

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Any astrophotographer can tell you the Milky Way is a galaxy, but how many have taken photos to show it? It sounds impossible — like trying to photograph a house from inside a closet — but it can be done, and more easily and strikingly than you'd think. You can't do it with a single photo, but if you combine several of them into a Milky Way composite, you can produce a stunning piece of astrophotographic art.

Get away from city lights and look to the south during mid-evening on a clear August night. There, curving up away from the horizon toward the northeast, is the silvery sprinkle of stars and nebulae that makes up the Milky Way.

In the south lie the Teapot of Sagittarius and, to the west of it and now setting, the red-eyed Scorpion. Tilt your head a little to the right and let your eyes sweep along the run of the Milky Way — up through Aquila and Cygnus past the zenith and down toward Cassiopeia, rising in the northeast. There it is — about one half of our home Galaxy.

Now take a closer look at the southern end — see how it thickens and brightens around Sagittarius? This isn't any trick or optical illusion: 33,000 light-years from where you stand lies the heart of the Galaxy. Suns crowd other suns in this rich, star-saturated region; the thickening you see is the bulge of our Galaxy's nucleus.

Seeing all this is easy — getting it on film is a little more difficult. Nevertheless, the equipment and techniques are simple enough: you need fast film, fast lenses, and an equatorial mounting — and the equatorial isn't absolutely necessary.

Let's start with the film. Use one with a speed of 400 ASA — black-and-white, color slide, or color negative. Although fast film has more grain than slow film, short exposure times are important since you want to photograph as much of the Galaxy as you can in a single night.

If you have a darkroom, black-and-white is the best choice. The film is cheaper and you can make your own prints easily. Color negative film adds expense and difficulty — and working through a commercial photo-finisher can drive you nuts. Still, when the prints are well-done, the results are superb.

If you don't have a darkroom, you'll do best with color slides since they are easy to take and have processed. But viewing calls for a projector and, for a composite pictorial, you'll need prints.

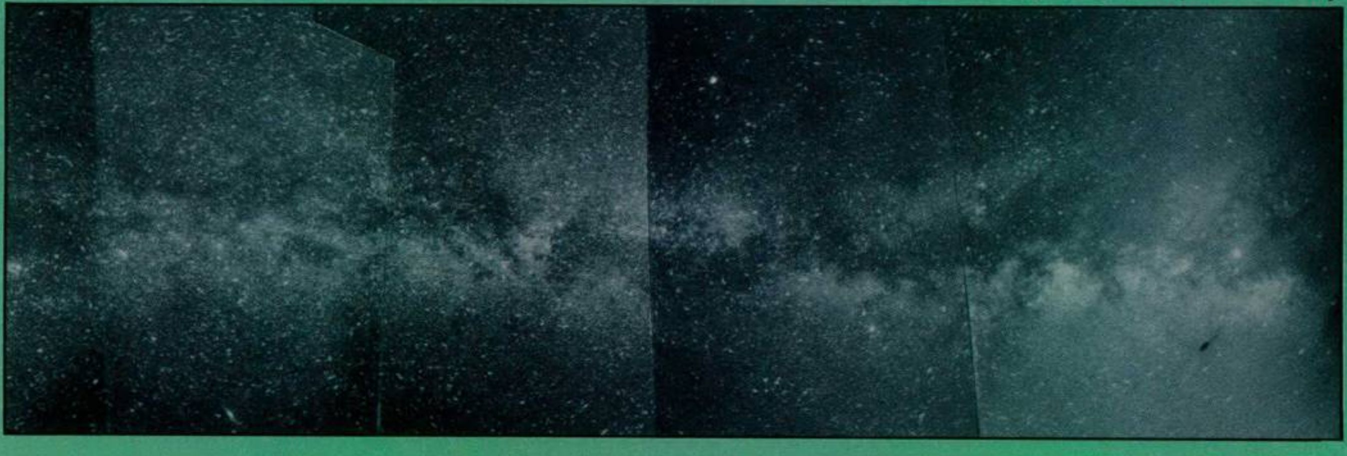
One caution: never try to save money on "off-brand" films and cheap processing — they're too risky. You never know what you'll get when they come back. If you want to save money, buy brand-name fresh-dated film at a discount store — but pay a little extra to have it processed by the manufacturer.

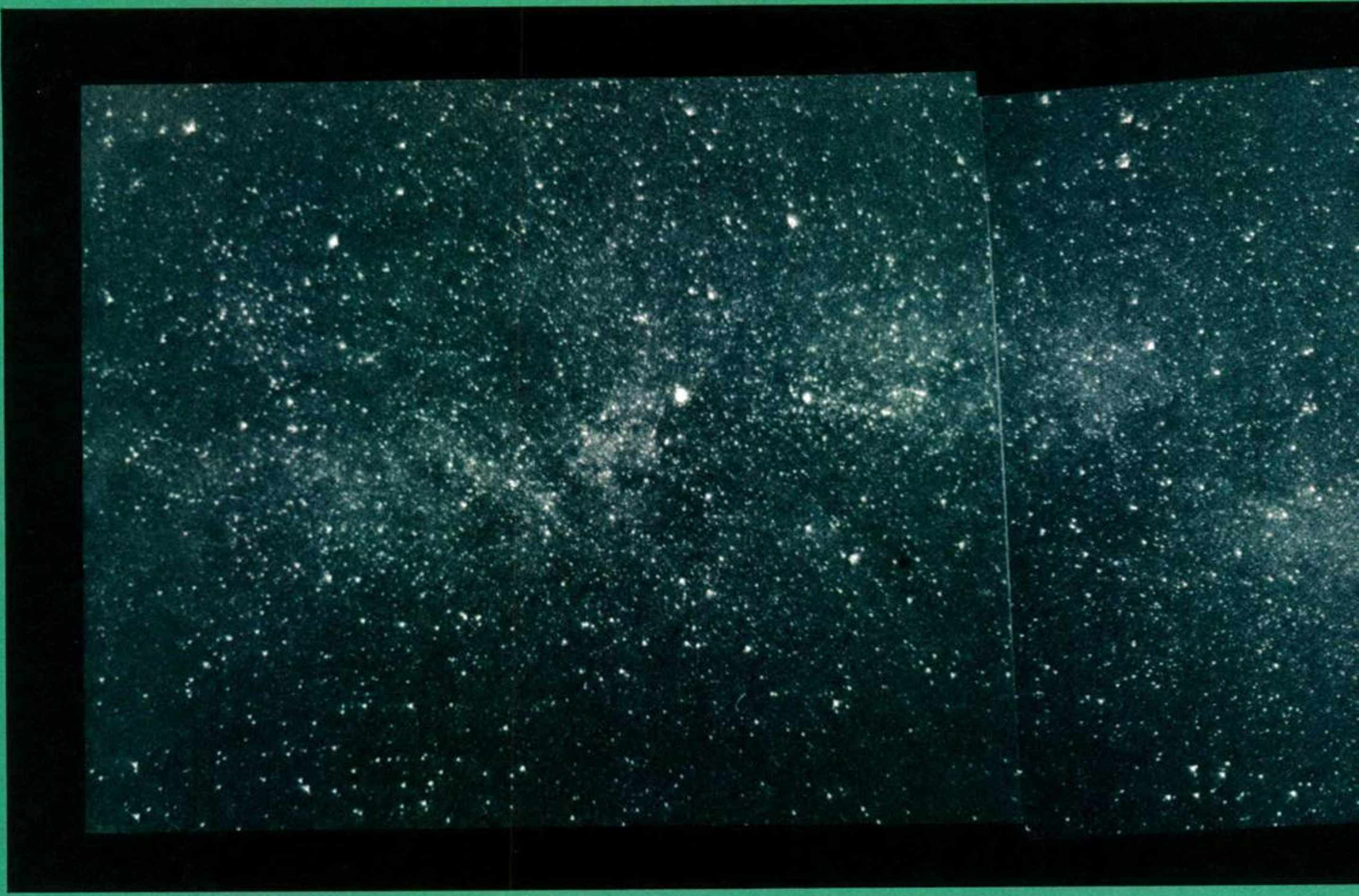
Probably the best camera to use is a 35mm; they're the most versatile and give you the greatest variety in film choices. The camera doesn't have to be an SLR, but it should have provision for time exposures — look for either a B or T setting on the exposure dial. Lens interchangeability is a plus, but not essential.

The lens you use can be anything from a telephoto to a wide-angle. A telephoto is good for capturing individual star clouds, a normal lens will take in much more sky and still not lose too much detail, and a wide-angle takes in broad reaches of the Galaxy at the expense of fine detail.

Since the Milky Way spreads so far and wide, you might be tempted to go for the widest lens possible: a fish-eye. But these are usually unsatisfactory since they show only the Galaxy's coarsest structural features and have a

Composite photo by Richard Berry.





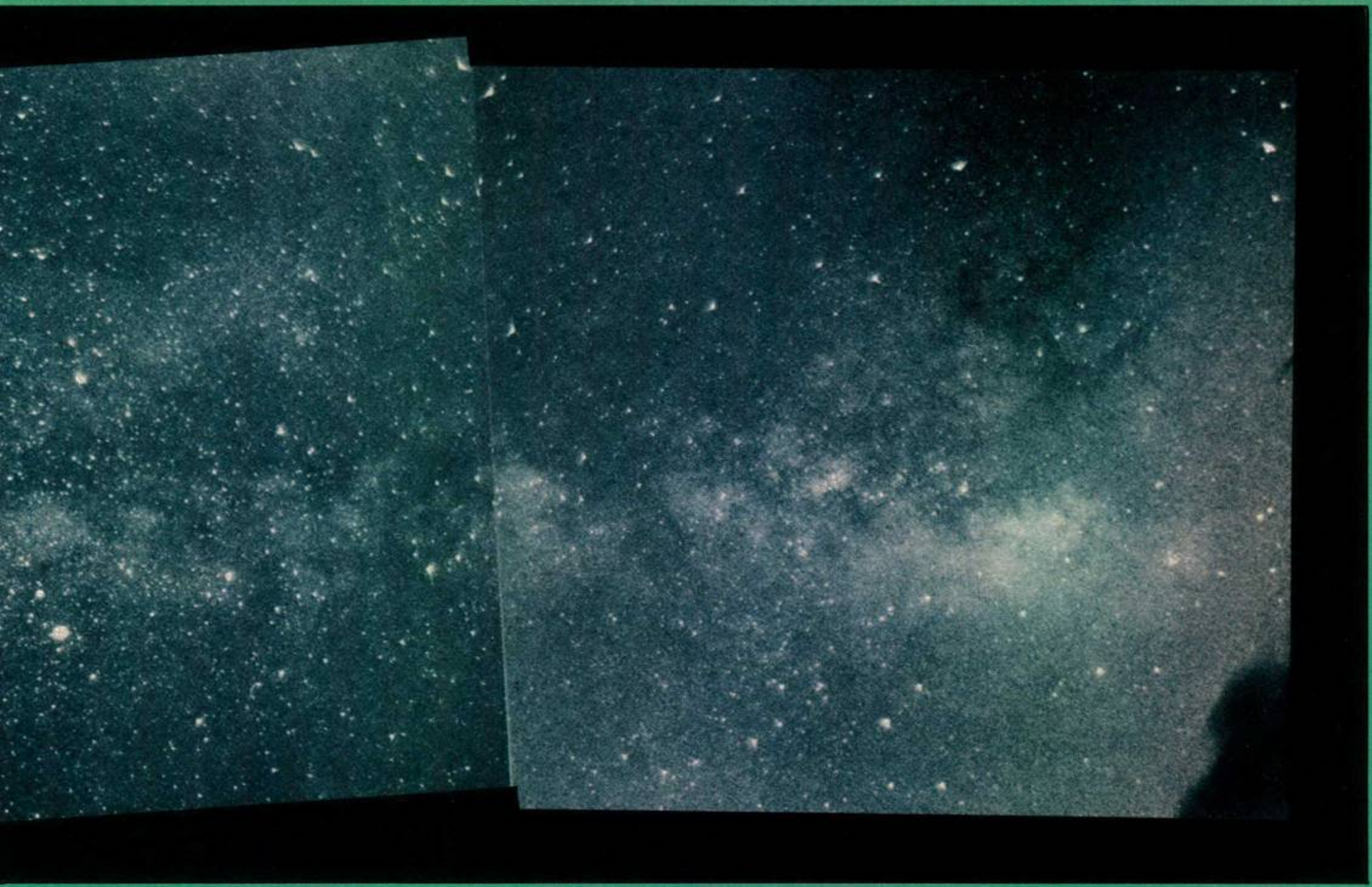
Above: Milky Way composite made by Richard Berry from three 10-minute exposures taken through a 28mm f/2.8 lens. Left: a dark nebula in Ophiuchus photographed by A.K. Parizek.

lot of distortion. In addition, inexpensive fish-eye lenses are miserably slow — around f/8 — and they don't record faint stars.

Among true wide-angle lenses, those usually available run from 17mm to 35mm. Unfortunately, many of them share two common defects with a lot of lenses, especially their cheaper counterparts: vignetting and bloopy images at the edges and corners.

Vignetting at the edge of the frame happens for two reasons. First, the light entering the lens at the edges of the field of view has to travel through the edges of the lens where some of the rays are cut off. Second, the light is focused onto the film at a shallow angle. This slanting incidence spreads the light out and "dilutes" it, so less light strikes a given area and you get less exposure. At 30° from the optical axis, the image loses 44% of its brightness thanks to this effect.

Those bloopy, gull-wing images in the corners of the frame show up because photographing high-contrast points of light on a black background is about the toughest test you can give a lens. Many lenses that are perfectly adequate for ordinary photography



fester with optical aberrations when used to photograph star-fields.

So what's to be done? Aside from shelling out more money for a better lens, you can avoid the problem in two other ways. One is to use a longer focal length lens. In general, the less extreme the angular coverage for the lens, the less obvious the aberrations. But this forces you to make more exposures because doubling the focal length quadruples the number of photos you need to cover a given area.

Another approach is to close the lens down a stop from wide-open. Although this lengthens the exposure time, it will usually clear up the bloopy images and alleviate some vignetting. Make some star-tests to see just how far down to stop the lens to get acceptable images in the corners; one stop may not be enough. Most normal lenses perform very well by the time you stop them to f/2.8, and that's fast enough with 400 ASA films.

The mounting you should use depends on the kind of pictures you want. You can take a surprisingly impressive photo if you simply set the camera on a tripod, aim it south, and let the exposure run for 2 to 5 minutes. The stars will trail, of course, but the general shape of the Milky Way will be clear. If you photograph in color, stars and nebulae will show as pretty colored streaks. On the other hand, the exposures you'll need to make a crisp, detailed panorama of the Milky Way call for guiding.

If you decide to guide, the tracking accuracy requirements aren't stringent — especially when compared to taking a photo through a telescope. With a 50mm lens, just keeping a star centered in a 100x eyepiece will suffice — and with wider lenses, the tolerances are correspondingly less. An ordinary eyepiece will work for guiding, but one with cross hairs — illuminated or "glow in the dark" — will be a lot easier to use.

Attach your camera to the telescope piggyback style, focus the lens to infinity, and set its aperture to fully open, or whatever gives best images. Then aim the telescope at the star-field you want, turn on the drive or start turning the right ascension slow-motion, and keep your guide star centered while you open the shutter.

A few test exposures will show you how well you have to guide to keep the stars from trailing. A good drive will keep you right on target during a 10-minute exposure, especially if you take the trouble to re-balance the scope after you attach the camera.

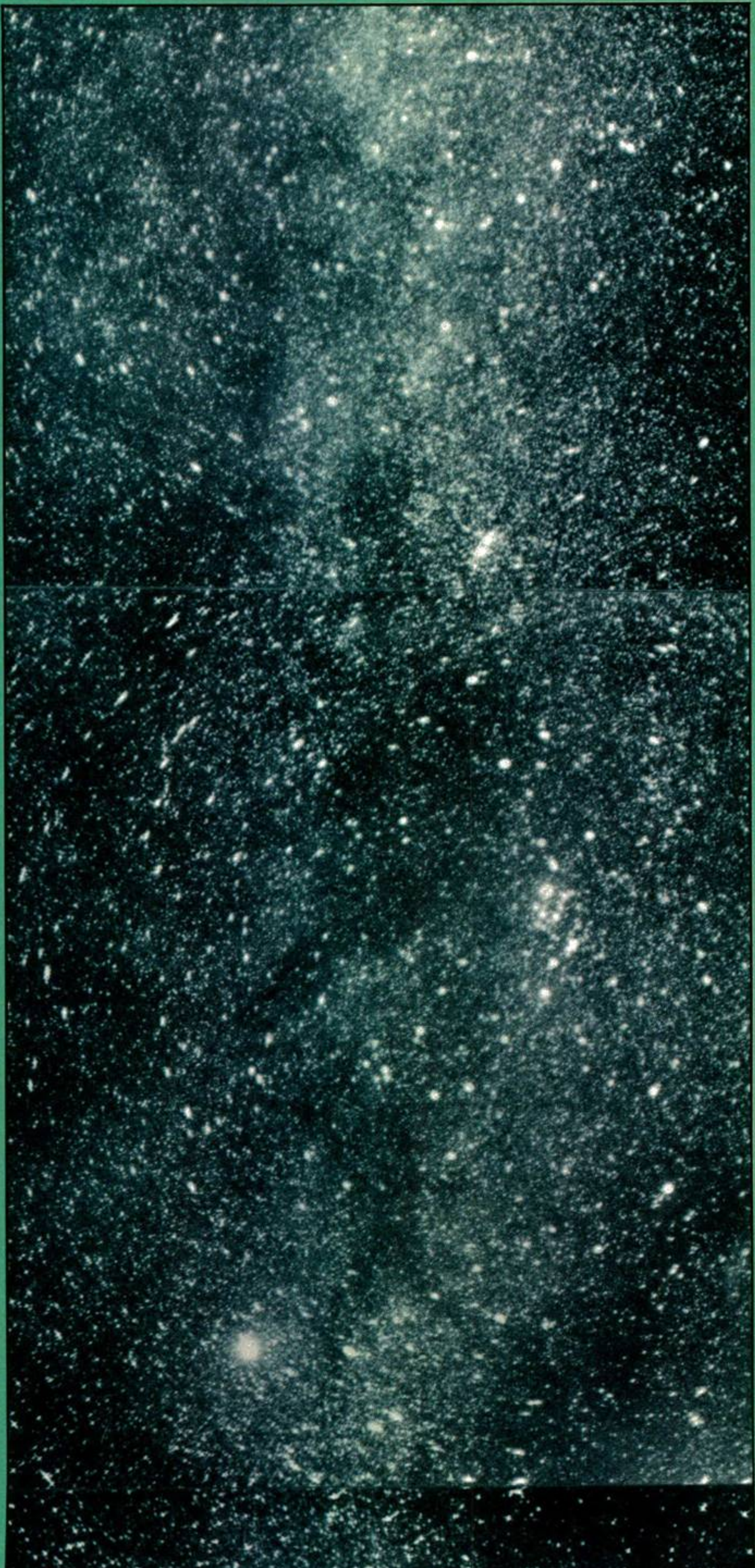
A 5 to 30-minute exposure should be long enough — depending on sky conditions, lens f/ratio, and film. Once again, you'll have to experiment before you find the time that gives the best pictures.

When you take photos for a composite, always make sure you have plenty of overlap between frames — even 30% isn't too much. This will insure that you never have to use the vignetted and bloopy edges of each frame when assembling your montage.

Since the southern parts of the Milky Way set earliest, you should begin there as soon as the sky becomes dark. After photographing the Sagittarius region, work your way north. By 2:00 a.m. daylight time, Sagittarius will be very low, if not already set. But parts of the winter Milky Way — Cassiopeia and Perseus — will be well-up in the northeast by then. You may be able to photograph as far as Taurus or Auriga before morning twilight catches you.

To capture the rest of the winter Milky Way, you'll have to wait until later in the year. By around 3:00 a.m. in mid-November, you'll catch the Milky Way in Auriga, Orion, Monoceros, Canis Major, and Puppis. These constellations are well up before dawn, but you can see the same sky earlier in the evening if you wait until January or February.

When you've photographed the Milky Way down to Puppis, you'll have captured just about all of our Galaxy you can from your latitude. To get the remaining third that never rises over



This composite by Richard Berry shows the starry expanse of the autumn Milky Way from Cassiopeia to Auriga.

your southern horizon, you'll have to pack your bags for a trip to the southern hemisphere!

Lining up your star-field photos into a gigantic panorama isn't very difficult, but it calls for carefully matching your prints. This is when doing your own darkroom work really pays off.

Develop the negatives to the same level of contrast and keep it close to normal for your first efforts. The prints should all be enlarged the same amount and made on the same grade of paper. If you're careful, you can dodge some of the vignetting in the corners. Process the prints in one batch so their tone stays identical. Wash, dry, and press them flat without any variations. If your easel puts white borders on the prints, trim them off with a matte knife or an X-acto knife and a good straight-edge.

Then lay the prints out on a table and assemble them to make a rough panorama. Get enough heavy Bristol board from an art supply store to serve as backing for the prints you have — you may have to tape several boards together if your panorama is large. Now, carefully examine each print and its neighbors to see which has the best images.

Fitting your prints to each other will be tricky. You'll want them to overlap so that they line up precisely, star-by-star, but the farther you move from the center of each print, the larger the image scale gets.

The only line along which the image scales match is equally distant from the centers of two adjacent prints and perpendicular to the line joining their centers. This sounds complicated, but a bit of trial-and-error work on scrap prints will improve your skill at print-fitting without damaging your new collage.

After you've laid out the whole panorama, work from the middle and stick down the first print to the board with photo-print cement. Don't use rubber cement; your prints will turn yellow in a year or two if you do.

Once you have the first print down, work in both directions, fitting each print to the one next to it. Trim off the excess with your knife and straight-edge. Then paste it down carefully. You may want to hold each print down with tape until you get it positioned and trimmed. Work slowly and carefully.

When you have the whole thing assembled, go back and touch up the print edges with spotting or retouching toner. All your work will be worth it when you prop your composite up, stand back, and take it all in — a portrait of your Galaxy.

— Robert Burnham

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Consider the possibilities in astrophotography: Capture the glowing yellow-red detail of the Ring Nebula (M57), including the 15th-magnitude central star, in **4 minutes;** or the complete red, blue and green structure of the Orion Nebula, including the diffuse outer loop in **6 minutes;** the fiery-red gaseous detail of the Omega Nebula (M17) in **5 minutes;** the dust lanes and spiral detail of the Andromeda Galaxy (M31) in **5 minutes or less!.** Exposure times so short you really don't need a drive corrector or guide telescope— so short that even a beginner can obtain astrophotos of exquisite detail.

Manufactured exclusively for Crown Optics by Meade Instruments Corp., the World's largest manufacturer of reflecting telescopes for the serious amateur, the DS-10 and DS-16 make available to the average amateur visual and photographic capabilities only dreamed of until now. Unlike competing large-aperture telescopes, the Meade DS-Series Telescopes include **Equatorial Mounts** as standard equipment: you track effortlessly along **one** axis, not along 2 simultaneous axes as with an alt-azimuth mounting. Add the optional Electric Motor Drive System and you're ready for fully automatic tracking and the deep-space photography you never thought possible.

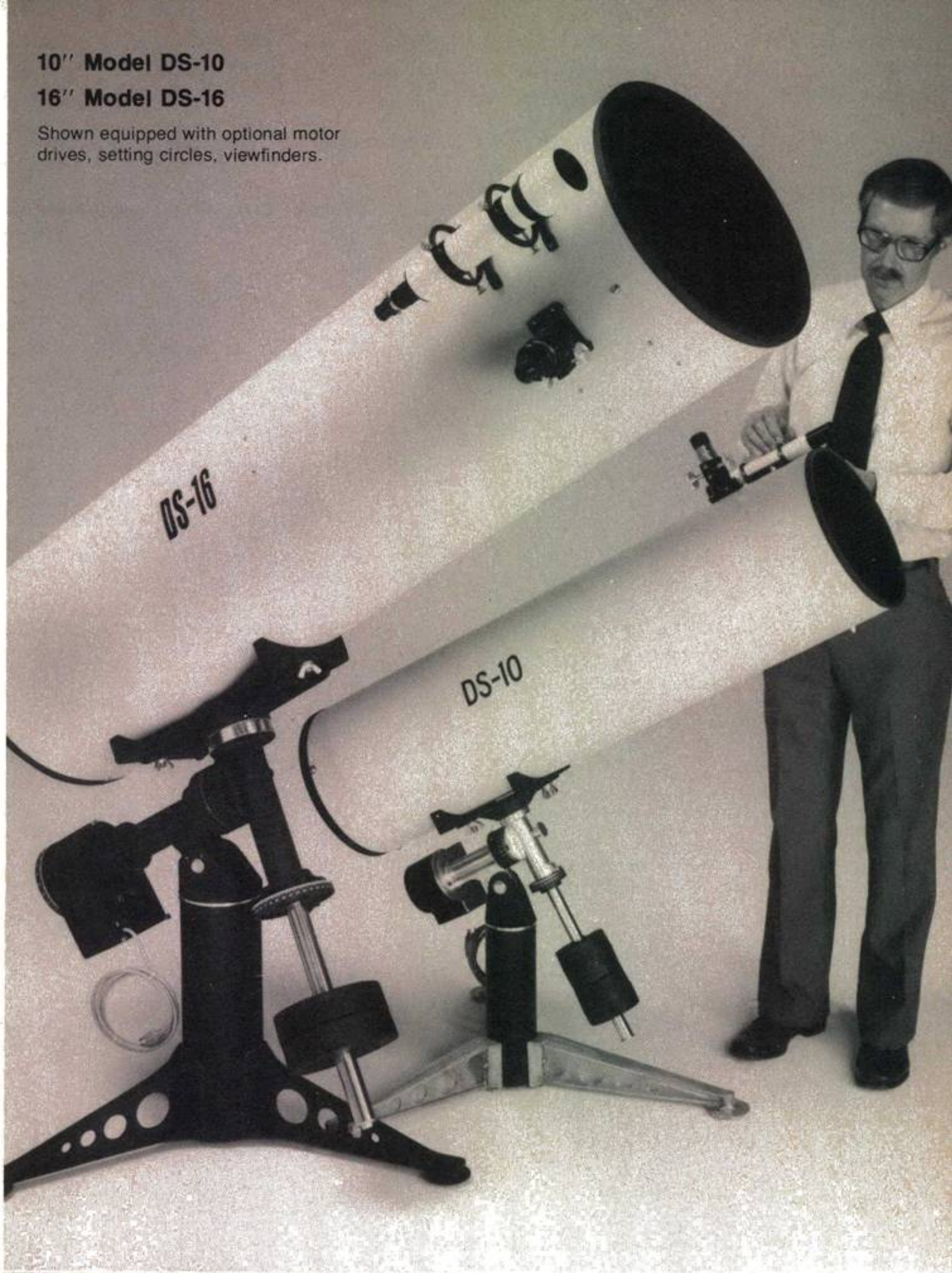
SPECIFICATIONS— Meade DS-10: 10″ f/4.5 Reflecting Telescope. With null-figured, diffraction-limited Pyrex parabolic primary mirror and matching (2.60″ M.A.) 1/10-wave flat elliptical secondary; #67 rack-and-pinion focuser at convenient observing position; Kellner 25mm (46×) eyepiece; Sonotube 12″ I.D. × 46″ long, sealed and attractively Zolatone coated; all-metal, precision-machined Equatorial Mount, with ultrasmooth nylon bearings and 1″ solid steel shafts; rock-solid, low-profile pier and tripod legs; locks on both axes. Complete: **$449.50**.

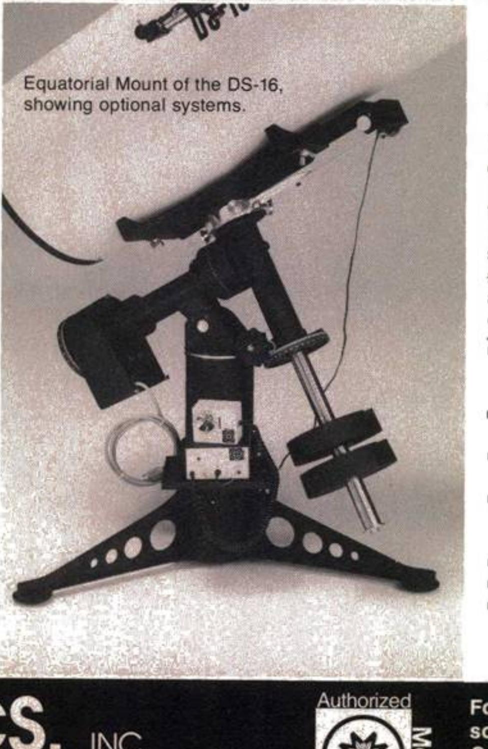
SPECIFICATIONS— Meade DS-16: 16″ f/4.5 Reflecting Telescope. With null-figured, diffraction-limited, Pyrex parabolic primary mirror and matching (4.00″ M.A.) 1/10-wave flat elliptical secondary; flotation mirror cell; #67 rack-and-pinion focuser at convenient observing position; Kellner 25mm (73×) eyepiece; Sonotube 18″ I.D. × 68″ long, sealed and attractively Zolatone coated; all-metal, precision-machined Equatorial Mount, with ultrasmooth Nylon bearings, 1½″ solid steel shafts, and 5″-dia. polar thrust surface; rock-solid, low-profile pier and tripod legs; locks on both axes. Complete **$995.00**.

10″ Model DS-10

16″ Model DS-16

Shown equipped with optional motor drives, setting circles, viewfinders.





Equatorial Mount of the DS-16, showing optional systems.

OPTIONAL SYSTEMS

#787	**Electric Motor Drive System (115v./60Hz) for DS-10**	**$ 60.00 ppd**
#897	**Electric Motor Worm-Gear Drive System (115v./60Hz) for DS-16**	**155.00 ppd**

See our ad on the next page for the wide array of other optional accessories for the DS-10 and DS-16. These include: higher-and lower-power eyepieces; viewfinders; telenegative amplifiers; nebular filters; drive correctors and photoguide telescopes for long-exposure photography; camera adapters. The giant Meade #680 Focuser may also be ordered in place of the standard focuser on the DS-10 and DS-16. See Bulletin DS for details.

- Both models are **complete** instruments at the prices listed— no additional parts or accessories required to start observing.
- Easy Portability— Field set-up time is about 2 minutes for the DS-10, 5 minutes for the DS-16.
- The DS-10 and DS-16 carry the Meade Full-Year Limited Warranty.
- **Prompt shipment** on both models— Order by mail, or by dialing the Crown TOLL-FREE 800-number. (See next page for details.)
- All prices include packing; F.O.B. Costa Mesa, Calif.
- Delivery direct to your door by U.P.S. or truck freight.
- Send for **Free Bulletin DS,** with full details on these incredible deep-space telescopes, or enclose $3.00 for complete General Catalog of Meade astronomical products. (See next page for details.)

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P.O. Box 8672, Newport Beach, Calif. 92660

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Order TOLL-FREE on our nationwide 800-number!

PHOTO-GUIDE TELESCOPES— Each with coated, air-spaced objective, rack-and-pinion focuser, diagonal prism, 9mm crosshair eyepiece.

1— **Model 300PG:**	D=80mm (3.1")	F=1200mm (f/15)		**$185.00 ppd.**
2— **Model 280PG:**	D=60mm (2.4")	F=700mm (f/11.7)		**79.50 ppd.**
3— **Model 210PG:**	D=50mm (2.0")	F=600mm (f/12)		**57.50 ppd.**
Mounting Rings:	for #210PG		per. pr.	**9.75 ppd.**
	for #280PG, #300PG		per. pr.	**12.50 ppd.**

RACK-AND-PINION FOCUSERS— All 3 models include helical-cut rack and variable-tension adjustment for ultra-smooth focusing without backlash. Universal bases fit all tube sizes. Standard 1¼" eyepiece holders.

4— **Model 67** — Strong, lightweight design for 4" to 10" telescopes. 2-3/16" travel. An excellent value. **$23.50 ppd.**

5— **Model 640** — A heavy-duty deluxe focuser for 6" to 16" telescopes. Full 3" travel for both visual and photographic applications. **$36.95 ppd.**

6— **Model 680** — Accepts both 1¼" and 2" eyepieces. Full 3" travel for photo or visual observing with 6" to 16" telescopes. **$44.95 ppd.**

ACCESSORY CASES— For secure storage of eyepieces, Barlows, filters.

7— **Model 54:** Thick-wall polyethylene with latch and handle. Holds 7 eyepieces & Barlow, filters. Dims. 12" × 8" × 3¾" **$12.50 ppd.**

8— **Model 50:** Luggage-quality metal case with 2 latches, handle; foam custom fits to your accessories. Dims. 20" × 12" × 6½" .... **$39.50 ppd.**

NEBULAR FILTERS—Revolutionary 3-channel filters block natural airglow & sodium and mercury emissions from city lights. Dramatically improve telescope performance visually and photographically.

9— **Model 907:** 18mm aperture, for .965" O.D. eyepieces **$42.50 ppd.**

10— **Model 908:** 23mm aperture, for 1¼" O.D. eyepieces **$49.95 ppd.**

11— **Model 911:** 36mm aperture, threads directly onto rear-cell of Meade and Celestron Schmidt-Cassegrains. .... **$69.50 ppd.**

12— **PHOTO-VISUAL COLOR FILTERS**— Top quality optical glass, dyed-in-the-mass, with excellent spectral homogeneity. Thread directly into 1¼" O.D. barrels. Filters may be piggybacked. **#8 Light Yellow—#11 Yellow-Green—#12 Yellow—#21 Orange—#23A Light Red—#25A Red—#47 Violet—#58 Green—#80A Blue—Polarizer (30% transmission).** Each filter: **$7.50 ppd.** Set of any 6: **$43.50 ppd.**—Full set of 10: **$70.00 ppd.**

13— **VARIPAK DRIVE CORRECTOR—Model 43:** Supercompact 2" × 3" × 4" design. Fast-slow pushbuttons. Variable speed control. Operates from 12 volts D.C., plugs into standard auto cigarette lighter. The 12-watt output is sufficient for most telescopes to 14" aperture .... **$59.50 ppd.**

14— **VARIGUIDE DRIVE CORRECTOR— Model 41:** The finest R.A. drive corrector available. Includes aircraft-type joystick controller for continuously variable correction rates. Variable speed control. Use with any telescope drive rated up to 12 watts. Operates from 12 v. D.C. or 115 v. A.C. **$110.00 ppd.**

15— **6 × 30mm VIEWFINDER—Model 631:** Same unit supplied as standard equipment on Meade 6" and 8" reflecting telescopes. Actual field: 4°. Includes coated, achromatic objective lens and crosshair eyepiece. Precise push-pull focusing. Thousands now in use. Bracket, with collimation screws and lock-nuts, included. Bracket fits all tubes 6" to 12½". **$24.50 ppd.**

16— **6 × 30mm RIGHT-ANGLE VIEWFINDER— Model 633:** As in (15), but with prism for convenient right-angle observations. Prism may be rotated 360° for maximum viewing comfort. 2-ring bracket included. **$29.50 ppd.**

17—**SERIES 1 KELLNER EYEPIECES (1¼" O.D.)**—High-quality, fully-coated optics housed in chromed barrels threaded for filters. Sold elsewhere for $18.00 to $22.00. **KE 9, 25, 40mm** .... each **14.75 ppd.**

18— **SERIES 1 ORTHOSCOPIC EYEPIECES (1¼" O.D.)**— Well-corrected 4-element designs, fully coated, threaded for filters. Sold elsewhere for $26.00 to $30.00. **OR 4, 6, 9, 12.5, 25mm** .... each **$23.75 ppd.**

19— **SERIES 2 MODIFIED ACHROMATIC EYEPIECES (1¼"O.D.; MULTI-COATED)**—Custom 3-element designs, precisely corrected for chromatic and spherical aberrations. Finest obtainable under $20.

FOCAL LENGTHS: MA 6,9,12,25mm, 40mm Wide-Field, ea. $18.95 ppd.

20— **MODIFIED ACHROMATIC 40mm EXTRA-WIDE-FIELD EYEPIECE (1¼" O.D.; MULTI-COATED)**—Yields widest field obtainable in 1¼" O.D. Enlarged field lens and special field-flattening optics with long eye relief. **$27.50 ppd.**

21— **SERIES 2 ORTHOSCOPIC EYEPIECES (1¼" or .965" O.D.; MULTI-COATED; PARFOCAL)**— The excellent 4-element high resolution optics of these oculars are all the majority of serious amateurs ever require. Razor sharp 45° fields. Both 1¼" and .965" O.D. sets parfocalized.

FOCAL LENGTHS: OR 4, 6, 9, 12.5, 18, and 25mm .. each $27.50 ppd.

22— **RESEARCH-GRADE ORTHOSCOPIC EYEPIECES (1¼" O.D.; MULTI-COATED; PARFOCAL)**—The largest selling premium-quality eyepieces in the world, universally acclaimed to be the finest eyepieces obtainable. 4-element systems, unsurpassed in color correction, resolution, and flatness of field. 45° field. **OR 4, 7, 10.5, 16.8, 28mm** .... **each $42.50 ppd.**

23— **RESEARCH-GRADE ERFLE EYEPIECES (1¼" O.D.; MULTI-COATED; PARFOCAL)**— For breathtaking wide-angle observations. 65° fields, parfocalized with our Research-Grade Orthoscopics.

FOCAL LENGTHS: ER 7, 12.4, 15.5, 20mm .... each $47.50 ppd.

VIEWFINDERS— With helical focusers for ultraprecise control of image sharpness. Coated, achromatic objectives of new Meade design yield fully corrected images throughout the field. Actual field on 50mm models: 4¼°; on 60mm models: 3½°. Crosshair eyepiece, dewcap, dustcap included.

24— **8×50mm—$46.50 ppd.** Brackets: **$9.75/pr. ppd.**

25— **8×50mm RIGHT-ANGLE—$53.50 ppd.** Brackets: **$9.75/pr. ppd.**

26— **GIANT 9×60mm—$65.00 ppd.** Brackets: **$12.50/pr. ppd.**

27— **GIANT 9×60mm, RIGHT ANGLE—$71.50 ppd;** Brackets: **$12.50/pr.**

28— **RESEARCH-GRADE ERFLE 32mm EYEPIECE (2" O.D.; MULTI-COATED)**—Wide-angle, fully-corrected 65° field. The finest eyepiece obtainable in 2" barrel. **$99.50 ppd.** Adapter Barrel for 1¼" O.D. **$10.75 ppd.**

29— **DELUXE CAMERA ADAPTERS**— Adapt your camera to telescope focuser instantly. Individually machined from solid bar aluminum and brass. All units permit both eyepiece-projection and first (prime) focus photography. Specify your camera brand and either 1¼" or .965" focuser. All 1¼" units are threaded for filters. **Nikon, Canon, Minolta, Pentax K, Konica, Olympus OM, or Universal Thread-Mount** .... **$29.50 ppd.**

30— **2X and 3X TELENEGATIVE AMPLIFIERS (1¼" O.D.; MULTI-COATED)**— Warranted without qualification to be the world's finest Barlow lenses. Full 26mm clear apertures, Multi-Coated, with virtually flawless optical corrections at all photo-visual wavelengths on any telescope. **2X Model 122: .. $29.50 ppd.; 3X Model 123: . . . $32.50 ppd.; 2X Model 131:** Per Model 122, but for .965" focusers; 18mm clear aperture, Multi-Coated. **$22.50 ppd.**

31— **2X-3X VARIABLE TELENEGATIVE AMPLIFIER (1¼" O.D.; MULTI-COATED)— Model 127:** Made to same research standards as Model 122 above, but mounted in a machined sliding cell, for variable power settings between 2X and 3X. Engraved scale indicates power. Multi-Coated . . . **$39.95 ppd.**

32—**PARABOLIC MIRRORS**— The very finest. 1/10-wave, diffraction-limited primary mirrors. Aluminized and quartz overcoated. Immediate shipment. **6"f/8 . . . $65.00 ppd.; 6" f/5 . . . $75.00 ppd.; 8" f/6 . . . $95.00 ppd. 10" f/6 . . . $195.00 ppd.; 12½" f/6 . . . $335.00 ppd.**

33— **SECONDARY MIRRORS**— Elliptical 1/10-wave flats. Aluminized and overcoated. Immediate shipment. **1.30" M.A. . . . $12.00 ppd.; 1.52" M.A. . . . $16.00 ppd.; 1.83" M.A. . . . $19.50 ppd.; 2.14" M.A. . . . $23.00 ppd.; 2.60" M.A. . . . $27.50 ppd.; 3.10" M.A. . . . $47.50 ppd.**

34—**ILLUMINATED RETICLE GUIDING EYEPIECE (1¼" O.D.)**—New phosphorescent etched double-line reticle permits line illumination from dim to extremely bright. Remote brightness control and 6 ft. cable. Modified Achromatic 12mm optical system. Precisely focusable reticle. Complete . . . **$49.95 ppd.** Interchangeable barrel for .965 " O.D. . . . **$7.50 ppd.**

35—**MICROMETER RETICLE**—Full-field scale for accurate measurements of double star separations, planetary angular diameters, etc. Interchanges with standard 4-line reticle of Item (34), above . . . **$19.50 ppd.**

36—**ERECTING PRISMS**—Fully coated Porro prisms. Invert the astronomical image for terrestrial observations with astronomical telescopes. **1¼" O.D. . . . $29.75 ppd.; .965" O.D. . . . $25.75 ppd.**

DIAGONAL PRISMS— Optical-quality right-angle prisms, fully coated.

37— **Model 915:** Fits .965" focusers, accepts .965" eyepieces **$16.95 ppd.**

38— **Model 917:** Hybrid diagonal— fits .965" focusers, accepts 1¼" O.D. eyepieces .... **$26.95 ppd.**

39— **Model 918:** 18mm clear aperture. Fits 1¼" focusers, accepts 1¼" eyepieces .... **$22.95 ppd.**

40— **Model 918A:** 30mm clear aperture. Fits 1¼" focusers, accepts 1¼" eyepieces. Enlarged aperture increases field at low power **$26.95 ppd.**

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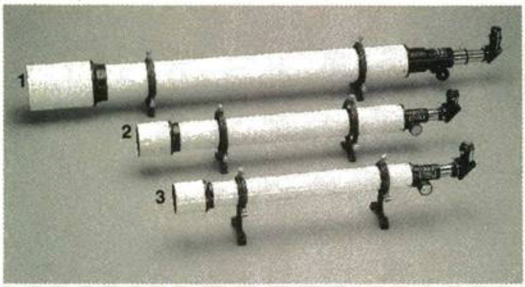

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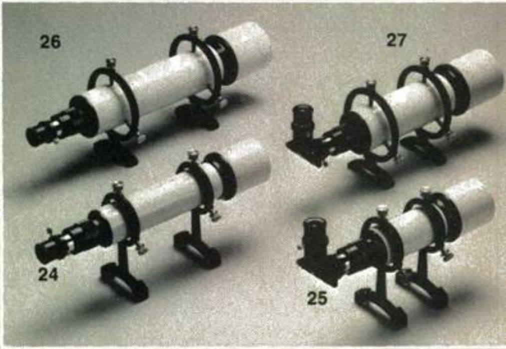

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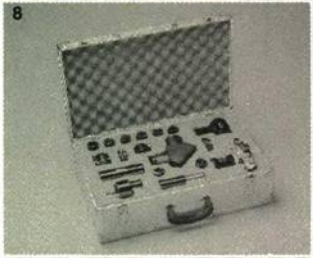
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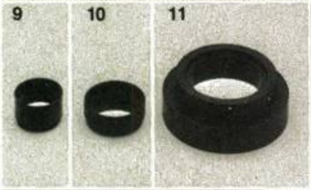

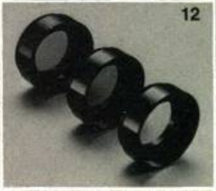
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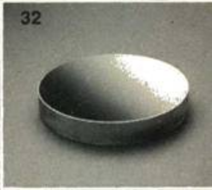
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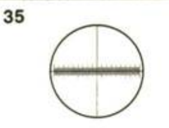
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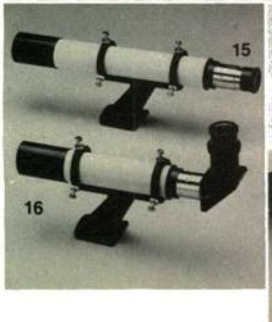

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Meade Model 2080:
8″ Schmidt-Cassegrain

Meade Model 2120
10″ Schmidt-Cassegrain

Model 2120
Model 2080

Shown with optional equatorial wedges, field tripods, and astrophoto equipment.

Research-Quality Accessories for Meade and Celestron Schmidt-Cassegrains

All of these Meade accessories are of the finest optical and mechanical quality available, and all (except item H) may be used interchangeably on Meade and Celestron Schmidt-Cassegrains.

PRICE LIST

A—	**Off-Axis Guider Body**	$45.50 ppd.
B—	**T-Adapter**	19.00 ppd.
C—	**Tele-Extender**	19.00 ppd.
	T-Rings (specify camera brand)	each 10.00 ppd.
D—	**Telecompressor Lens** (f/5), Multi-Coated	37.50 ppd.
E—	**Extender Tube** (to use Telecompressor with Off-Axis Guider)	11.50 ppd.
F—	**Wide-Field Adapter Systems** (Visual Telecompressors) Includes Telecompressor Lens, Special T-Adapter, and Diagonal Prism.	
	For .965″ eyepieces	71.50 ppd.
	For 1¼″ eyepieces	77.50 ppd.
G—	**2″ Diagonal Mirror.** Includes adapters for 1¼″ and 2″ O.D. eyepieces	159.95 ppd.
H—	**Dual-Axis Drive Corrector, Model 46**—Attaches in 2 minutes to Meade Models 2080, 2080C or 2120. No drilling required. Includes R.A. drive corrector, Dec. motor and clutch system, joystick controller. Operates from 115v. /60Hz or 12v.D.C.	219.50 ppd.
I—	**Solar Filters**—Optical glass, Inconel-coated, for professional-level solar observation. For Meade 2080 or Celestron 8.	
	#955: 8″ Full-Aperture Solar Filter	165.00 ppd.
	#956: 3″ Off-Axis Solar Filter	90.00 ppd.
J—	**Series 6 Drop-In Filters** (not shown). Optical glass. Includes Pink, Yellow, Yellow-Green, Red, Blue, Neutral (0.6). Set of 6 filters	35.00 ppd.

For Nebular Filters, Thread-In Filters, Drive Correctors, Barlow Lenses, Illuminated Reticle Eyepieces, and Erecting Prisms, see the accessories listing on the facing page. These accessories are fully compatible with Meade and Celestron Schmidt-Cassegrains.

Crown Optics breaks the price barrier on the World's finest 8″ and 10″ Schmidt-Cassegrains. Order the renowned Meade Model 2080 or superb new Model 2120 from us and save hundreds of dollars off the list price:

Meade Model 2080 8″ Schmidt-Cassegrain— This is the telescope that is revolutionizing modern amateur astronomy and astrophotography. Supplied complete as shown with: ball-bearing fork mount, motor drive, 6 ft. power cord, dual slow motion controls, setting circles, 6 x 30mm viewfinder, diagonal prism, luggage-quality carrying case, and 2 multi-coated Modified Achromatic eyepieces (9mm and 25mm), dust covers, instruction manual **$739.95**

Meade Model 2080C 8″ Schmidt-Cassegrain— Identical in all specifications to the Model 2080 above, but with 2 fully-coated Kellner eyepieces (9mm and 25mm) in place of the Modified Achromatic eyepieces, and with rugged foam-lined gift carton packing substituted for the carrying case **$699.95**

Meade Model 2120: 10″ Schmidt-Cassegrain— Over 56% more light-gathering power than 8″ models. Complete with ball-bearing fork mount, motor drive, 6 ft. power cord, dual slow motion controls, setting circles, 8 × 50mm viewfinder, diagonal prism, luggage-quality carrying case, and 2 multi-coated Modified Achromatic eyepieces (9mm and 25mm), dust covers, instruction manual **$1779.00**

Telescopes are a full-time business with us. Both before and after your purchase our highly qualified staff of 23 technical, order-desk, and shipping personnel are available Mon. - Fri. 8:30 - 5:00 to answer your questions, whether concerning an anticipated order or the use and application of a telescope or accessory you have already received.

PRICE LIST

MEADE MODEL 2080: 8″ SCHMIDT-CASSEGRAIN TELESCOPE	Base price, complete	$ 739.95
MEADE MODEL 2080C: 8″ SCHMIDT-CASSEGRAIN TELESCOPE	Base price, complete	699.95
MEADE MODEL 2120: 10″ SCHMIDT-CASSEGRAIN TELESCOPE	Base price, complete	1779.00
Meade Equatorial Wedge for 2080/2080C		50.00
Meade Equatorial Wedge for 2120		80.00
Meade Variable-Height Field Tripod for 2080/2080C/2120		135.00
Meade High Transmission Coating for 2080/2080C		70.00
Meade High Transmission Coating for 2120		110.00

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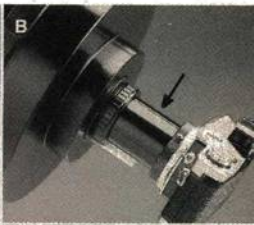

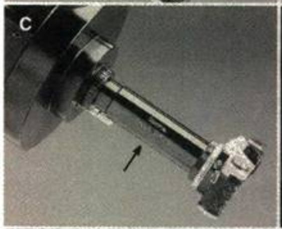

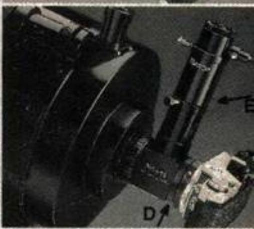

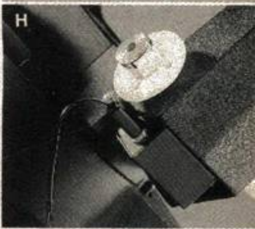

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800-854-7485 (orders only)

from anywhere in the continental U.S.A., except California. Order Desk Hours: 8:30 - 5:00 Pacific Time Monday through Friday

For General Information, or to place orders from all other geographical areas, dial direct (not collect): **714-966-1200.**

ORDERING INFORMATION

1. **Mail and Phone Orders only!** No dealer sales.
2. **Payment.** Personal or bank check, money order, VISA, or Master Card. (Immediate shipment on complete telescopes requires payment by cashier's check, M.O., or credit card.)
3. **All orders** are financially guaranteed by Meade Instruments Corporation.
4. **All products** are brand-new (no "seconds"!) and are normally available for immediate shipment.
5. **Within the U.S.A.:** Shipment by United Parcel Service direct to your door, fully insured, safe arrival guaranteed. **Canadian Orders:** See our Order Form for further details.
6. **All products** carry the Meade Instruments Full-Year Limited Warranty, and are backed by the Crown Optics reputation for trust and fair-dealing with our customers.
7. **California residents:** Add 6% Sales Tax.
8. **Outside North America:** Contact your Meade Instruments international distributor, or write directly to Meade Instruments Corporation for ordering information.

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P.O. Box 8672, Newport Beach, Calif. 92660

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ASTRONOMY REVIEWS

Are We Alone?
Robert T. Rood and James S. Trefil
262 pages, hardcover, **$14.95**
Charles Scribner's Sons (1981)

Three schools of thought dominate contemporary discussions of extraterrestrial life. The first holds that the number of intelligent, communicating civilizations in our Galaxy reaches into the millions. The second is a bit more conservative — estimating "only" a few hundred thousand. The third and most pessimistic group claims the evolution of life in the Galaxy is so rare that the number of civilizations capable of communicating with us is fewer than ten.

Most people who have an opinion about the matter of extraterrestrial intelligence (ETI), belong to the first group. Carl Sagan, through his books and TV program, *Cosmos*, has encouraged such optimism in the last decade. Despite this, attitudes appear to be shifting to favor the pessimists — largely because we are beginning to suspect that the conditions for intelligent life to develop and prosper may be rare.

Much of *Are We Alone?* is devoted to interpreting what is commonly referred to as Drake's equation — usually written:

$$N = Rf_p n_e f_l f_i f_c L$$

The formula attempts to derive a value (N) for how many advanced communicating civilizations might exist in our Galaxy.

The equation looks impressive — until you realize how poorly known most of its constituent terms are. But having nothing else to work with, the authors adopt it as the best approach for learning about civilizations in our Galaxy. They spend about half the book describing each term in the equation individually and assigning values according to the three schools of thought.

In detailed discussions of each term in the equation, readers discover just how enormous the problems are for assigning even a vaguely reasonable value for each. For instance, although the rate of formation of stars (R) in the Galaxy is prodigious — approximately one star every 20 years, according to the authors' "conservative" estimate — the rate for stars like our Sun is far lower. And these G stars, the authors carefully point out, are the most likely to harbor life as we know it.

Probabilities steadily dwindle and uncertainties increase as we move to the right in the equation. The formation of planets (f_p), another necessity for life to develop, presents still larger problems. We see stellar incubators all over the night sky, but how many of these infant stars will develop planets?

Rood and Trefil support the idea that a supernova could scatter the nebula with certain types of heavy atoms that we see on Earth, and the shock wave could induce contraction needed to accrete planets.

The new solar system would need at least one planet neither too hot, like Venus, nor too cold, like Mars (n_e). The new planet must also possess enough material to produce an atmosphere neither too thick nor too thin.

The first three terms in the equation are difficult enough, but the last four are nearly hopeless. How can we determine the frequency of life (f_l) developing on a newly formed planet if the only model we have is Earth itself.

Last in the Drake equation are the three interrelated terms most difficult to assess. We have no guarantees that the organic molecules just described will form intelligent life (f_i). A certain degree of intelligence could develop and die out as the dinosaurs did. We can't even say if our intelligence is desirable from the natural selection point of view. We've learned how to extinguish ourselves with bombs, while ants, sharks, and ferns have done very well for many millions of years.

And other questions intrude: if intelligent beings did prosper, would they necessarily *try* to communicate (f_c)? Would they even reach the point of developing an advanced scientific community, a natural prerequisite to communication itself? And how long would they attempt interstellar communication before calling it hopeless (L)? After all this, it's easy to see how easy it is for pessimists to harbor doubts about extraterrestrial intelligence.

Most of the facts and arguments relating to how life can and cannot develop are presented in the first half of *Are We Alone?* The authors use the second half of the book to defend their views and present a plan of attack on the problem of SETI.

After the authors admit their biases and explain why they think G-type stars are needed to develop life and why that life should exist on planets and be composed of carbon-based organic molecules, they deal with the other variables. Subsequent chapters cover the nature of electromagnetic radiation, how a concentrated and organized effort to communicate may take place on Earth or on other planets in the Galaxy, how an ETI might detect life on our planet, and what our chances for survival are on an Earth faced with pollution, burgeoning population, and political strife.

Are We Alone? concludes with a look at our efforts at colonizing space, and space travel. Sooner or later, the authors suggest, Earth's resources will be depleted, pollution will ruin much of our planet, and overpopulation could finally force mankind to look for a new home in space.

The authors contend that these are evolutionary problems faced by all advanced civilizations, and if we locate another advanced life form, we'll discover that the same problems forced them to expand outward from their home planet.

Finally, after all this postulating, the authors don't commit themselves — they leave the question up to their readers.

Are We Alone? raises more questions than it answers and will probably disturb those readers who like pat answers. But the questions they raise are very interesting, and this book ought to provoke lively debates on ETI for many years to come. *Dan Koehler.*

Extraterrestrials: Where are They?
Michael H. Hart and
Ben Zuckerman, eds
182 pages, softcover, $9.50
Pergamon Press (1982)

In the past two decades, the mass media's melange of UFO sightings, advancements in astronomy, numerous space launchings, and an increasing number of space-oriented books and movies have helped foster the belief that life in the universe is not unique to Earth.

But this notion may be changing. In the latter part of 1979, a conference at the University of Maryland titled "Where are They? A Symposium on the Implications of Our Failure to Observe Extraterrestrials" investigated the question. During this two-day gathering, 29 participants presented papers which tended to refute or question the existence of extraterrestrial life.

Extraterrestrials: Where Are They? reprints 17 of these papers, and although the contributions range from technical to semi-popular, anyone interested in the subject ought to examine the book carefully.

The subjects discussed are diverse and include terraforming, the origin of life on the Earth, UFO lore, and interstellar propulsion systems. The credentials of many of the authors are impressive, and most of the papers include references for further reading. Additionally, since the symposium was tape-recorded, several papers conclude with transcripts of discussions that followed the oral presentation.

Many authors deal with the question of the propagation of life in the universe. Simple calculations show that, at moderate speeds of space travel, if the human race could scatter to the center of the Galaxy in less than the 3.5 billion years it has taken to produce mankind, it should find abundant evidence of older civilizations. This hinges critically on the assumption that life elsewhere disperses in a way similar to that on Earth.

The problem of time crops up often: one paper suggests that as we attempt to intercept radio signals from alien lifeforms, the travel time of the signal might be longer than the lifetime of the civilization that sent it. In a limited sense, this has happened with Earth's ancient civilizations. They no longer exist, but their "signals" — writings, monuments, artifacts — now propagate through time long after their makers are dust.

Anyone who speculates about extraterrestrial life is caught in a double-bind. If hypotheses assume that extraterrestrial life will resemble that found on Earth, they may be far too limited. Yet if we assume that such life need not parallel our own, the possibilities become infinite. Because of this endless diversity, the book hints that we should be searching for life in liquid ammonia, in mixtures of hydrocarbons, in extremely high-temperature milieus, in stars, in solid hydrogen, even in ordered patterns similar to the lobes of energy that flank some radio galaxies.

The book closes with the admonition that we are made of star-stuff and are continually creating humanity from the originally lifeless material of the universe. As we reproduce and grow, we may indeed find that we are unique in the cosmos — and are on the road to some sort of grand destiny.

We have so few hard facts to work with, we are tempted to follow philosophical predilections alone in discussing extraterrestrial intelligence. But why not? As the cynic once said, all we're doing is swapping ignorance. Because we lack a decisive test for theories, the same evidence can be used to support mutually opposing views. The great flaw in *Extraterrestrials* is its overall tone: while suggesting that belief in extraterrestrials is built on a rather flimsy structure, it supports its argument with reasoning no more solid! As Walt Kelly's Pogo said, "We are alone or we aren't — either way it's a mighty soberin' thought." *Gail O. Clark.*

The Astronomy of Birr Castle
Patrick Moore
83 pages, paperback, no price given
Tribune Printing & Publishing (1981)

Birr, County Offaly, Ireland, was once the location of the world's largest telescope — a 72-inch diameter speculum-metal Newtonian reflector completed in 1845 by William Parsons, third Earl of Rosse. Through this leviathan scope, astronomers first saw a galaxy — M-51, the Whirlpool — as a shining spiral instead of a soft blur of light. Despite relatively poor observing conditions in central Ireland, the instrument made many contributions to astronomy before it was retired in 1908.

Moore's book recounts the history of the Birr Castle telescopes — the 72-inch was the largest of several — and provides a biography of the third and fourth Earls who made and used these giants.

Be Stars
M. Jaschek and H.-G. Groth, eds.
523 pages, paperback, $65
D. Reidel (1982)

Class B stars whose spectra show lines of emission, often coupled with evidence of variability, are called Be stars. This volume contains the papers delivered at an I.A.U. symposium in April 1981.

Extragalactic Radio Sources
D. S. Heeschen and C. M. Wade, eds.
490 pages, paperback, $60
D. Reidel (1982)

The extragalactic radio sources of the title are many and varied. QSOs, radio and Seyfert galaxies — even SS 433 and BL Lacertae objects — are included in this collection of nearly 150 papers given at an I.A.U. symposium in August 1981.

Megalithic Science
Douglas C. Heggie
256 pages, hardcover, $27.50
Thames and Hudson (1981)

Subtitled "ancient mathematics and astronomy in north-west Europe," Heggie's book analyzes possible uses of ancient standing-stone circles and structures — including Stonehenge. The treatment is thorough and comprehensible.

Regions of Recent Star Formation
R. S. Roger and P. E. Dewdney, eds.
496 pages, hardcover, $59.50
D. Reidel (1982)

This volume presents the papers given in June 1981 at a conference on the dynamics and photochemistry of neutral clouds near H II regions. It contains 63 papers.

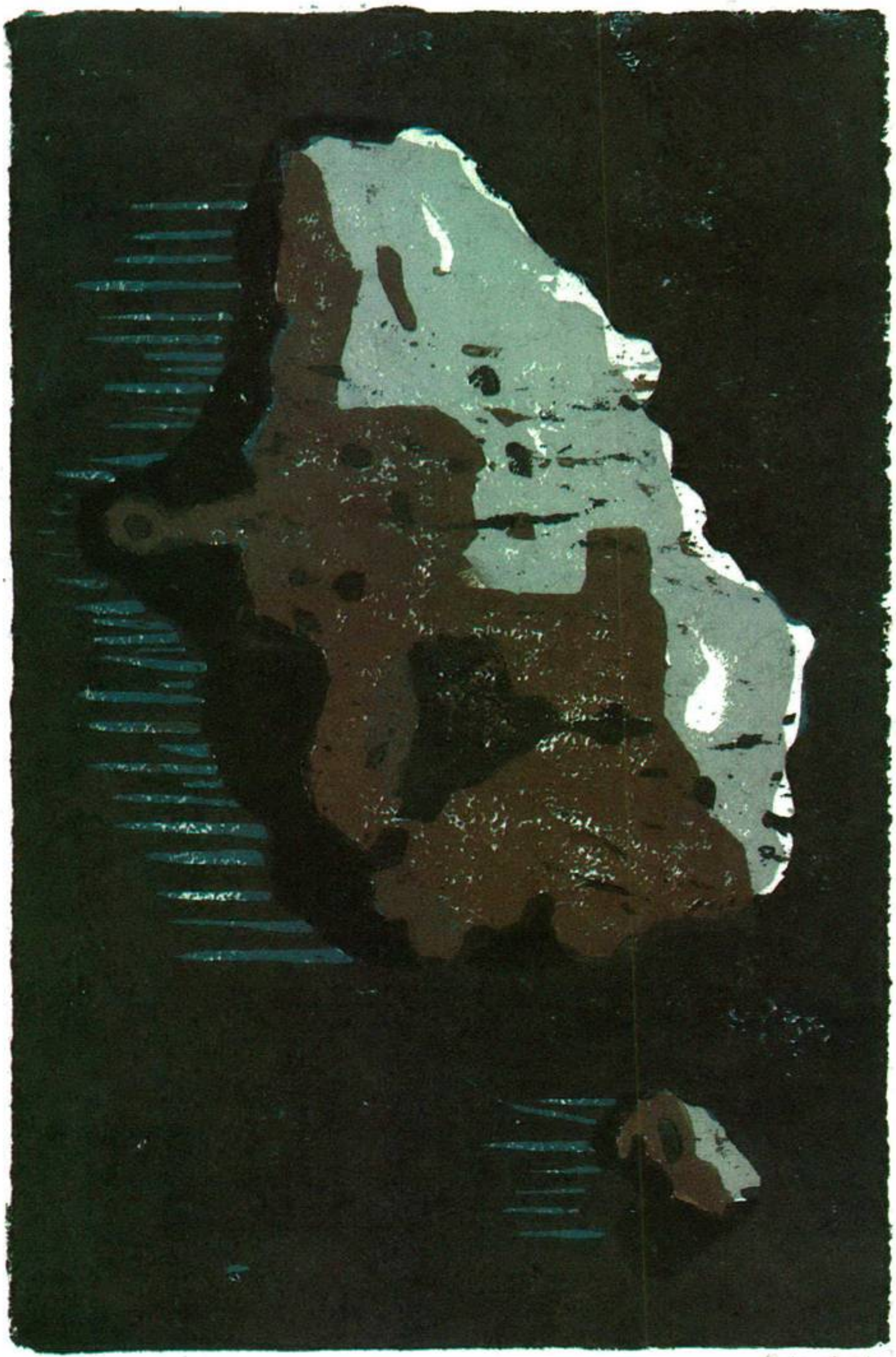
Extragalactic Adventure
Jean Heidmann
174 pages, paperback, $9.95;
hardcover, $19.95
Cambridge University Press (1982)

Subtitled "our strange universe," Heidmann's book is for the general reader. In it, the author — an astronomer at the Paris Observatory — recounts the history of the universe and forecasts its future.

gazer's gazette

roid fever

by
Ray Fabré



I'm what you might call a disadvantaged amateur astronomer. At our club star parties, while others ooh and aah over the brighter Messier and NGC objects, I diligently search for those elusive and overlooked, but numerous, members of our solar system — the asteroids.

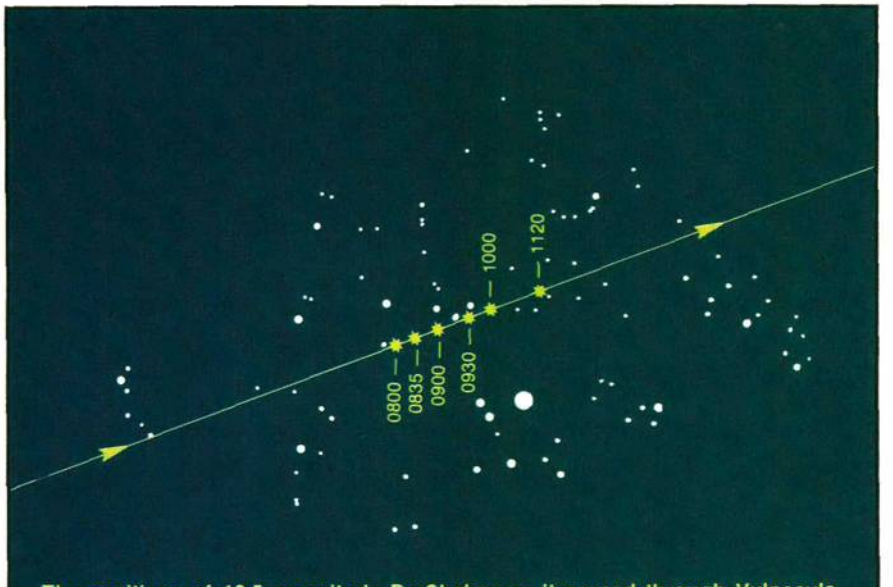
I wasn't always like this. I used to search out remote galaxies and faint planetaries, and I still do, but I've been bitten by the infamous "Roid" bug. The first question people ask when they discover I track asteroids for a hobby is "Why!?" The answer is simple. I don't know. It started out innocently enough; I saw a rough chart on how to find #4 Vesta, the brightest asteroid, printed in an astronomical magazine.

With chart in hand and full of enthusiasm, I pulled out my trusty 2.4-inch refractor and began the hunt for my first asteroid. Countless problems arose. I never could get the chart field to look anything like what I saw through the scope — too many stars. To further complicate my hunt, the chart only showed stars to magnitude 6.5. Even my little scope showed fainter stars than that! And the seeing conditions always seemed lousy.

I decided to make a drawing of the area the asteroid would pass through — including about ten stars — and look on another night to see which star had moved. The next night I checked for movement and counted twenty "new" stars. That's how I learned seeing conditions might add or subtract a full magnitude.

But with perseverance, a few new drawings, and a lot of pain in my neck and back, I found it. What was a fine "double star" the night before was now a lone object. Farther down my drawing, what had been a single star was now a wide double. Vesta was in the bag.

I didn't know it then, but the Roid bug had done me in. I have now



The positions of 13.5 magnitude Ra-Shalom as it passed through Vulpecula August 25, 1981.

identified, tracked, and submitted reports on more than 520 asteroids to the Association of Lunar and Planetary Observers (A.L.P.O.).

You don't need much equipment to hunt asteroids. A red flashlight, a clipboard to hold your chart, and *any* telescope will do for starters. You don't even need an equatorial mounting. A star chart like *Sky Atlas 2000.0* will help you pick a guide star in the area the asteroid will pass through. But, for starters, you can plot the bright asteroids listed every month in The Backyard Astronomer.

Patience is the prime ingredient in hunting asteroids. With the exception of the close approach asteroids, minor planets move slowly. In some cases you must wait until the next evening to detect movement, but sometimes you can see motion in a few hours — especially if the asteroid passes near a star.

In 1801, Italian astronomer Giuseppi Piazzi discovered the first asteroid, #1 Ceres. The finding caused quite an uproar in astronomical circles since the new body seemed to fit the popular "lost planet" theory of the Titus-Bode law of planetary distances. But then in 1802 Heinrich Olbers discovered #2 Pallas; #3 Juno followed in 1804 with #4 Vesta in 1807.

Then 38 years passed with no new discoveries. The cause of this dry period was the lack of sophisticated star charts. Anyone who has tracked 8th magnitude Neptune with star charts that only go down to 6th magnitude has an idea of the monumental task facing the early astronomers who searched for asteroids.

Two American observers became deeply involved in the early hunt — Christian Peters in New York, and James Watson in Michigan. They made their own star charts and discovered 70 asteroids — a remarkable feat for the 1800s. Night after night they sat behind the eyepiece carefully and accurately drawing in hundreds of stars in areas they suspected an asteroid might pass through.

Then they would re-check these same areas for intruders. Peters discovered 48 asteroids — a record that might never be broken. Each time I use a star chart I wonder how many more asteroids Peters or Watson would have discovered if they had good charts.

In 1891 Max Wolf changed the way astronomers search for asteroids by applying photography to the hunt. As asteroids move in relation to background stars, long exposures show them as short streaks.

Ironically, photography brought asteroids into disfavor with professional astronomers. They soon learned that thousands of asteroids populated our solar system, and at least one would show up and ruin a prized photo of some distant galaxy. This nasty habit earned asteroids the disparaging nickname "vermin of the skies."

Today, major observatories work overtime in hopes of finding a pesky little streak on their film. Astronomers now believe that from their dusty, scarred surfaces we will unlock some of the riddles of the solar system's origin. Talk of flybys, sample returns, and asteroid mining is common; the vermin have come into their own.

Asteroids tumble through space by the thousands, undisturbed since the time of creation. They come in many sizes — 1040 km to ½ km and smaller, and shapes from nearly round to cigar-like. Groups or clumps of them are arranged in specific distances and inclinations from the Sun; we call them "families." Those out near the orbit of Jupiter that lead or follow the giant planet are called the Trojan family. Some main belt asteroid families have intriguing names like Maria, Flora, and Hungaria.

The families attracting attention today are the Atens, Apollos, and Amurs. These are "Earth crossers," small, fast-moving minor planets that intersect Earth's orbit. They rarely approach closer than one A.U. to Earth, but in August 1972 people from Utah to Alberta, Canada, saw a spectacular daylight asteroid that skimmed the upper atmosphere and etched a 900-mile train of smoke and flame before it bounced back into space. Scientists concluded that if this rock had dipped just a bit deeper into our atmosphere, it would have struck with a force equal to an atomic bomb.

Although you don't have to serve as an early warning system, you can still check positions and magnitudes and help professional astronomers keep track of asteroids. If you want to give it a try, I suggest you start slowly with Dr. Gunter's selected "brighter" asteroids (see box on page 50).

But what happens if you really get into asteroid tracking, and observing two or three asteroids isn't enough? First you'll have to expand your equipment section and buy a good set of star charts. I use the *Hans Vehrenberg Photographic Atlases*. You'll also need a copy of the *Ephemerides of Minor Planets*.

Now that you have charts and the *Ephemerides*, look up the asteroids nearing opposition with magnitudes in reach of your equipment. Then transfer their positions to your star charts and make a reproduction of the charts so you can carry them out to your telescope. You can mark these up and save your expensive original star charts. You can also make a tracing of the area the asteroids will pass through, and use it as an overlay on the main chart. Keep track of the asteroids by marking their positions on the tracings.

Once you establish the body's position on the *Hans V* chart, look at your inexpensive charts and find a guide star that appears on *both* charts. Center this guide star in your field of view. Rotate the main chart to match the view in your wide-angle, low-power eyepiece, then "star hop" to the area the asteroid will cross.

Now the hunt is on. Switch to a medium-power eyepiece and compare your view with the chart. Then mark down the position of any interlopers. In most instances this is easy, especially with brighter asteroids, but sometimes the object lies close to a star of similar or brighter

plotting the asteroids

Several publications will help you in your search for asteroids. *Tonight's Asteroids,* published by Dr. J. U. Gunter, is a finder chart for several of the brighter asteroids. Gunter uses reproductions of the *Hans Vehrenberg Star Atlas* that go down to 13th magnitude, and includes historical information as well as technical data like size, distance, and magnitude. His charts are free for a self-addressed, stamped envelope sent to: Dr. J. U. Gunter at 1411 N. Mangum St., Durham, NC 27701.

If you get serious, you'll need th *Ephemerides of Minor Planets* — a annual publication of the Institute f Theoretical Astronomy, Leningra U.S.S.R. It lists all the numbered mino planets coming to opposition at 10 day intervals, their photographic magnitudes, and much more information. The *Ephemerides* is available for $6.00 from the Smithsonian Astrophysical Observatory, Cambridge, MA 02138.

Once you learn to plot asteroid positions accurately, you might want to submit your data to the Association of Lunar and Planetary Observers (A.L.P.O.) minor planet section: Frederick Pilcher, Minor Planet Recorder, Illinois College, Jacksonville, IL 62650.

magnitude. In this case increase power to separate the asteroid from the star.

One word of caution about the *Hans V* charts: they were taken with "blue" sensitive film, so red stars appear fainter than their visual brightness. It's easy to confuse at least two stars in the field with your target. You may have to wait several hours and check again for movement. The asteroid might also be distant and slow-moving; if you don't see movement after several hours, check again on the next clear night.

The orbits of most asteroids within reach of amateur equipment are so refined that you won't find many of the bodies off track. Still, some appear either ahead or behind, or north or south, of their orbit. Accurate data on these discrepancies is valuable to professional astronomers and makes a good observing project for the serious asteroid observer.

Magnitude estimates also need constant revision and astronomers still don't have accurate estimates on many asteroids. The best way to make a visual magnitude estimate is by comparing your asteroid with a star of known magnitude.

Recording occultations of stars by asteroids is the most important contribution backyard astronomers can make. This practice is one of the most immediately rewarding aspects of observing asteroids, but it is also frustrating. Predicted occultations can occur early or late, and in some cases not at all, because of the combination of small path corridors and minor discrepancies in the orbital elements.

For occultation timings you'll need last minute updates from the International Occultation Timing Association (I.O.T.A.) c/o David Dunham, Box 7488, Silver Spring, MD 20907. Then you'll have to dash madly to the newly predicted path, set up your equipment, hastily find the correct star, turn on the tape recorders (invaluable for reconstructing the chain of events), tune in WWV — the international timing station — wind your stopwatch, and cross your fingers.

At this moment every cloud in the world will pay you a visit, your radio's batteries will run out, or the mainspring on your stopwatch will break. But once in a while, everything will come together, and you'll see the target star dim to the magnitude of the asteroid.

Remember that the occultation of a star by an asteroid is *not* the same as an occultation of a star by the Moon. When a 12th magnitude asteroid passes in front of a 6th magnitude star, you see a six magnitude drop. Accurately time the duration of the dimming; since some asteroids have satellites, be on the lookout for multiple dimmings. With time and patience you can make meaningful contributions to professional astronomy by carefully monitoring these bodies. After all, asteroids comprise the largest number of solar system members. If you have observed planets, meteors, comets, and galaxies, why not add a few silently tumbling rocks to your list?

If the bug bites you, then at some future star party you'll put aside NGC viewing for a look at a couple of asteroids. Your friends will see you looking from eyepiece to star charts over and over again. They'll hear you mutter as you sort out the asteroid from the maze of stars in the field of view, and they'll ask you what you are doing.

You'll show them. "You see the faint guy just to the right of the double but under the four stars shaped like a box . . . ?" They will look, shake their heads, and walk away knowing you really do have rocks in your head — asteroids.

Ray Fabré is president of the Hawaiian Astronomical Society and has observed asteroids for 10 years.

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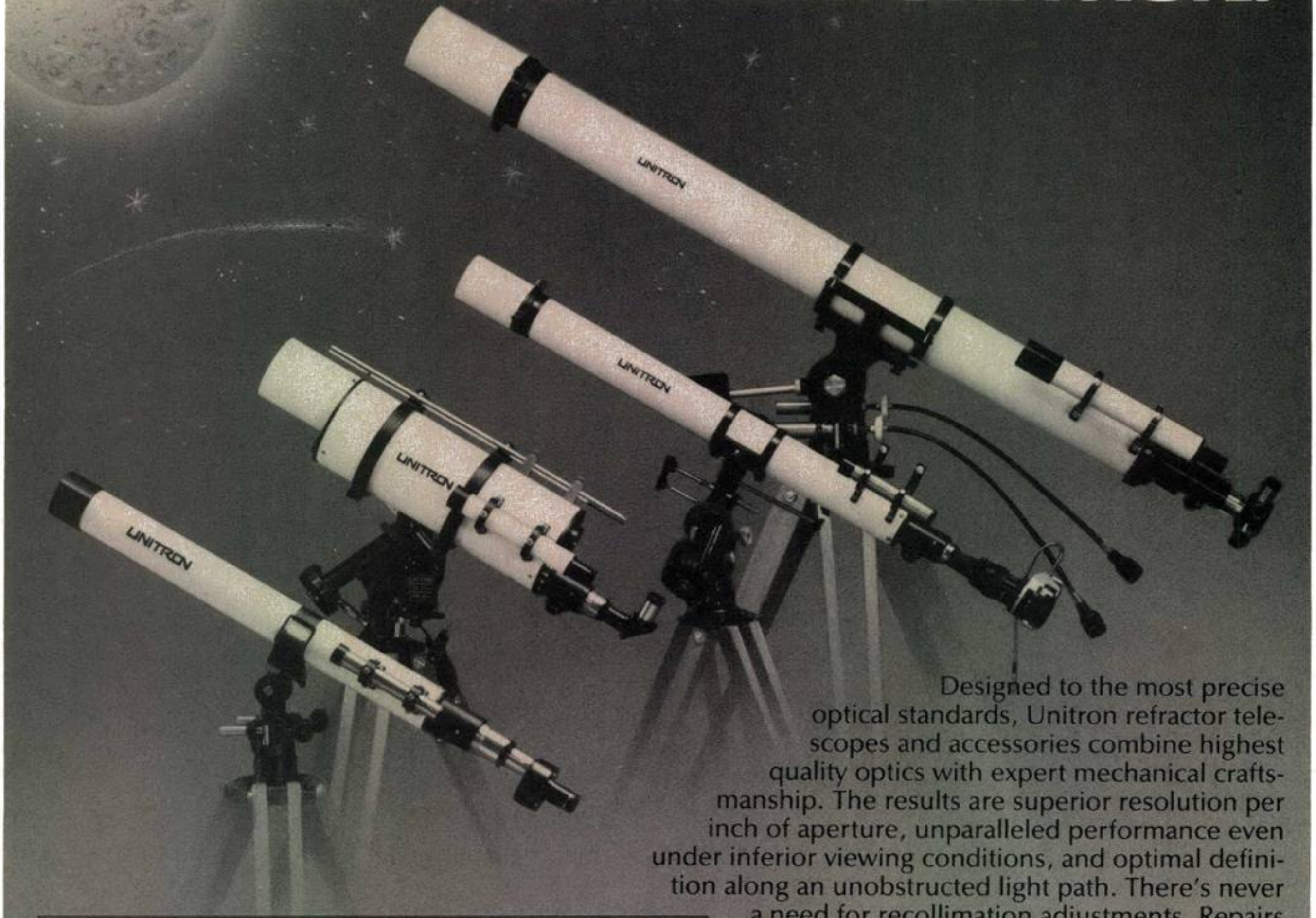

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#114 2.4" Altazimuth	35X, 50X, 72X, 100X	7°12′	60 mm, f/15	6X—24 mm, 6°22′ field	34½ in.	58 in.	16 lb.
#128 2.4" Equatorial	35X, 50X, 72X, 100X, 129X	7°12′	60 mm, f/15	6X—24 mm, 6°22′ field	34½ in.	60 in.	24 lb.
#140 3" Altazimuth	48X, 67X, 96X, 131X, 171X	4°20′	75 mm, f/16	8X—30 mm, 4°22′ field	47 in.	59 in.	23 lb.
#142 3" Equatorial	48X, 67X, 96X, 131X, 200X	4°20′	75 mm, f/16	8X—30 mm, 4°22′ field	47 in.	59 in.	46 lb.
#131-C 3" Compact Equatorial	48X, 67X, 96X, 131X, 171X, 200X	4°20′	75 mm, f/16	8X—30 mm, 4°22′ field	19 in.	60 in.	32 lb.
#150 4" Altazimuth	60X, 83X, 120X, 167X, 214X, 250X	3°22′	100mm, f/15	10X—40 mm, 2°54′ field	63 in.	64 in.	50 lb.
#152 4" Equatorial	38X, 60X, 83X, 120X, 167X, 214X, 250X	3°22′	100 mm, f/15	10X—40 mm, 2°54′ field	63 in.	66 in.	100 lb.

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easy steps to perfect polar alignment

Aligning an equatorial mounting is one of those tiresome chores most observers try to avoid. And you *can* ignore it most of the time. If you simply want to ramble around the skies, there's no pressing need to have your mounting in sync with the celestial sphere. But if you want to use setting circles to find some really faint object — or take photos through your telescope — you have to align the polar axis accurately.

Two methods stand out as particularly useful. One uses a cross-hair eyepiece and a couple of bright stars, the other a special sighting device.

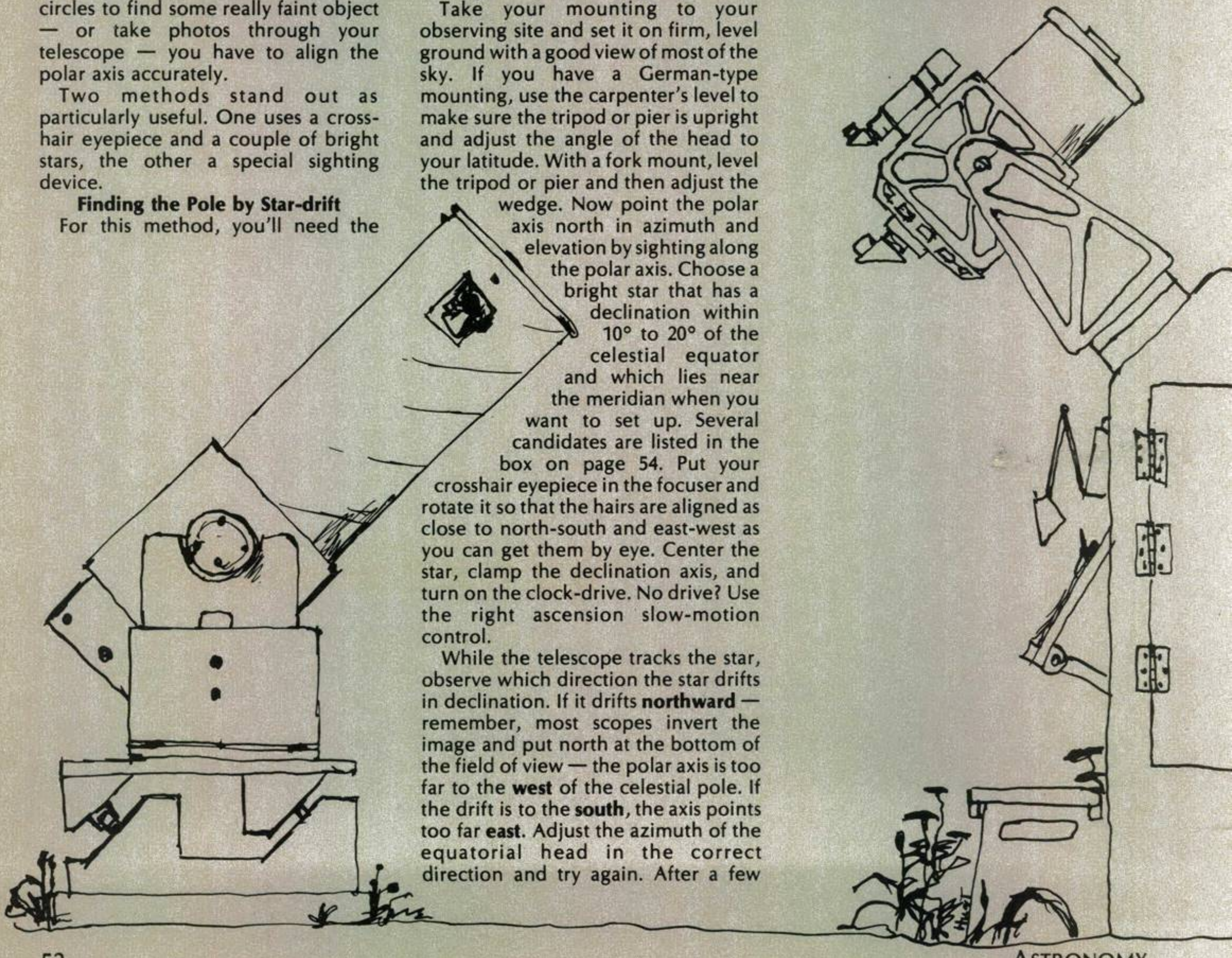
Finding the Pole by Star-drift

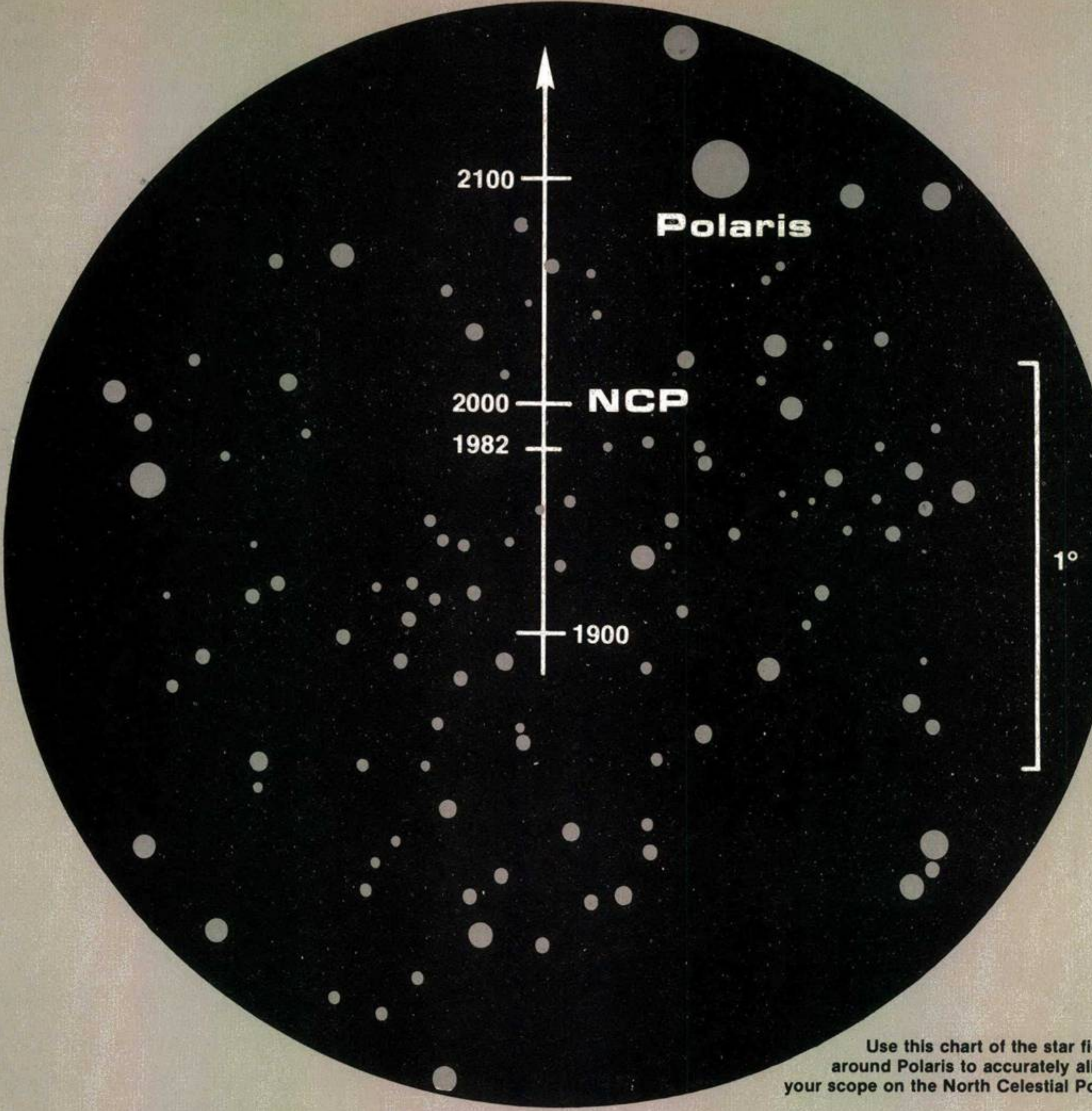
For this method, you'll need the adjusting tools the manufacturer provided with your telescope — usually an Allen wrench or two — and a carpenter's level. You'll also want a medium-power eyepiece with crosshairs. The crosshairs can be plain, illuminated, or "glow-in-the-dark" — as long as they show up against the sky.

Take your mounting to your observing site and set it on firm, level ground with a good view of most of the sky. If you have a German-type mounting, use the carpenter's level to make sure the tripod or pier is upright and adjust the angle of the head to your latitude. With a fork mount, level the tripod or pier and then adjust the wedge. Now point the polar axis north in azimuth and elevation by sighting along the polar axis. Choose a bright star that has a declination within 10° to 20° of the celestial equator and which lies near the meridian when you want to set up. Several candidates are listed in the box on page 54. Put your crosshair eyepiece in the focuser and rotate it so that the hairs are aligned as close to north-south and east-west as you can get them by eye. Center the star, clamp the declination axis, and turn on the clock-drive. No drive? Use the right ascension slow-motion control.

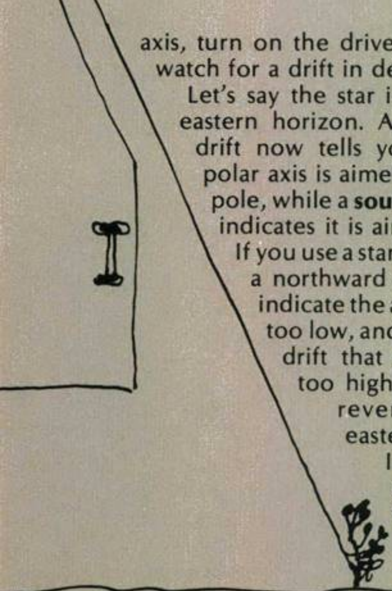
While the telescope tracks the star, observe which direction the star drifts in declination. If it drifts **northward** — remember, most scopes invert the image and put north at the bottom of the field of view — the polar axis is too far to the **west** of the celestial pole. If the drift is to the **south**, the axis points too far **east**. Adjust the azimuth of the equatorial head in the correct direction and try again. After a few trials, you will have reduced the drift to nearly nothing, and your azimuth alignment will be complete.

Altitude comes next. Locate another bright equatorial star, but this time about 20° above the eastern or western horizon. Center the star on the crosshairs, clamp the declination





Use this chart of the star field around Polaris to accurately align your scope on the North Celestial Pole.



axis, turn on the drive, and again watch for a drift in declination.

Let's say the star is above the eastern horizon. A **northward** drift now tells you that the polar axis is aimed **above** the pole, while a **southward** drift indicates it is aimed **below**. If you use a star in the west, a northward drift would indicate the axis is aimed too low, and a southern drift that it is aimed too high — just the reverse of an eastern star.

In either case, make the appropriate adjustment in the angle of the head or wedge — but do it carefully so you don't disturb the azimuth alignment. After a few trials, you'll have the alignment in altitude dead-on. Now go back and re-check the azimuth with a star near the meridian — just in case.

With the polar axis aligned, you can adjust your setting circles to read correctly. Just look up the coordinates of a star, center it in the eyepiece, and turn the circles, not the telescope, to the star's coordinates.

Finding the Pole by Sighting

The other polar alignment method uses an optical device called a bore-sight — a small, low-power telescope which points up through a hollow polar axis or clamps onto the mounting parallel to the polar axis. The eyepiece of a bore-sight contains etched plain crosshairs. Some also have a special reticle you can use to adjust the telescope mounting. With these you simply place the image of Polaris at a carefully determined spot in the field, and your scope lines up with the celestial pole. This takes only a few minutes. Several manufacturers sell ready-made bore-sighting devices and Sam Brown's book *All About Telescopes* tells you how to make one.

The chart on this page shows the star field immediately around Polaris. If you can identify the star field, you'll know exactly where the pole is. Note that the pole is moving — precession of the Earth's axis alters its position — and its track is shown. Polaris will become a better and better marker for the pole until the 22nd century when the distance between the two will start increasing. Using a bore-sight with plain crosshairs, you can zero the polar axis right onto the pole.

Bore-sights are also very handy for aligning the newly-popular equatorial platform mountings used with Dobsonian and other alt-azimuth telescopes (see "Equatorial Platforms," ASTRONOMY, January 1982). Most of these mountings have a flat bearing-plate with one face either parallel to the Earth's axis or at 90° to it. This makes it fairly simple to clamp a bore-sight to the plate for aiming toward the pole.

Is It Necessary?

Perhaps you're wondering why you should bother with polar alignment at all if you have slow-motions in both right ascension and declination. Couldn't you just find a guide star and keep it centered with both slow-motion controls? If you do that, you will track perfectly on your guide star — but that's only half the battle. Since the polar axis of the telescope is no longer turning precisely in line with the axis of the Earth, the field of view will rotate as you guide. You'll get a sharp image of the guide star, but the other stars in the photo will make short arcing trails around the guide star instead of pinpoint images. Good polar alignment is indispensible for accurate guided astrophotography.

Making It Easier Next Time

Setting the mounting up for each observing session is a chore. To simplify the procedure, you may want to build a permanent installation for your scope.

If you can build an observatory to house the scope, fine — polar alignment becomes a once-a-year job. But if this is out of the question, consider leaving *just* the mounting outdoors. Sheltering your mount from the weather is a lot easier than protecting an entire telescope.

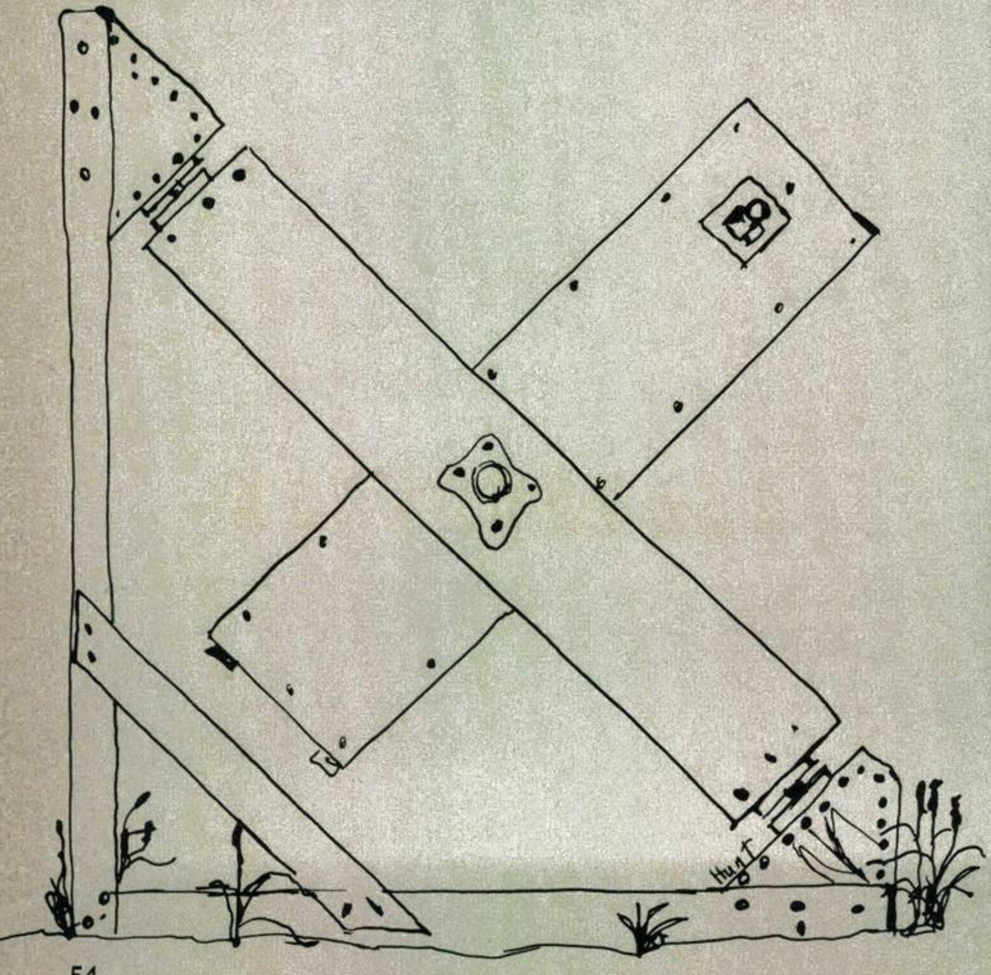
If you don't want to leave your mount outside, lay a foundation of brick, concrete, or concrete block. This will provide a stable place for setting up and make alignment much faster. With little splashes of paint, mark where the legs go. Next time you set up, put them back on the same spots.

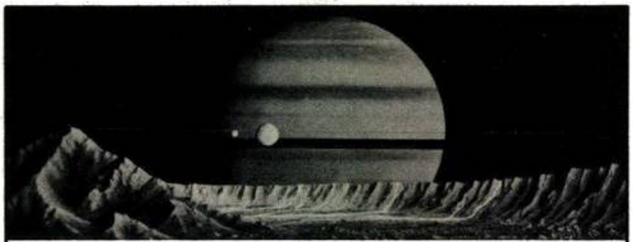
If you sink the blocks level with the ground, you'll be able to run a lawnmower right over them without interference. In cold climates, bed them deep enough to prevent frost heaving. And if you want to make it really simple and are willing to do some re-adjustment every spring, you can probably get by with just a single block for each leg.

— *Robert Burnham*

alignment stars (drift method)

star	mag.	r.a. (2000)	dec.
Beta (β) Cet	2.0	00h 44m	−17° 59′
Alpha (α) Cet	2.5	03h 02m	+04° 05′
Alpha (α) Tau	0.9	04h 36m	+16° 31′
Beta (β) Ori	0.1	05h 15m	−08° 12′
Delta (δ) Ori	2.2	05h 32m	−00° 18′
Epsilon (ε) Ori	1.7	05h 36m	−01° 12′
Zeta (ζ) Ori	1.8	05h 41m	−01° 57′
Alpha (α) Ori	0.5	05h 55m	+07° 24′
Alpha (α) CMa	−1.5	06h 45m	−16° 43′
Alpha (α) CMi	0.4	07h 39m	+05° 14′
Alpha (α) Hya	2.0	09h 38m	−08° 40′
Alpha (α) Leo	1.4	10h 08m	+11° 58′
Beta (β) Vir	3.6	11h 51m	+01° 46′
Alpha (α) Vir	1.0	13h 25m	−11° 10′
Beta (β) Lib	2.6	15h 17m	−09° 23′
Gamma (γ) Oph	3.8	17h 48m	+02° 42′
Alpha (α) Aql	0.8	19h 51m	+08° 52′
Theta (θ) Aql	3.2	20h 11m	−00° 49′
Alpha (α) Aqr	3.0	22h 06m	−00° 19′





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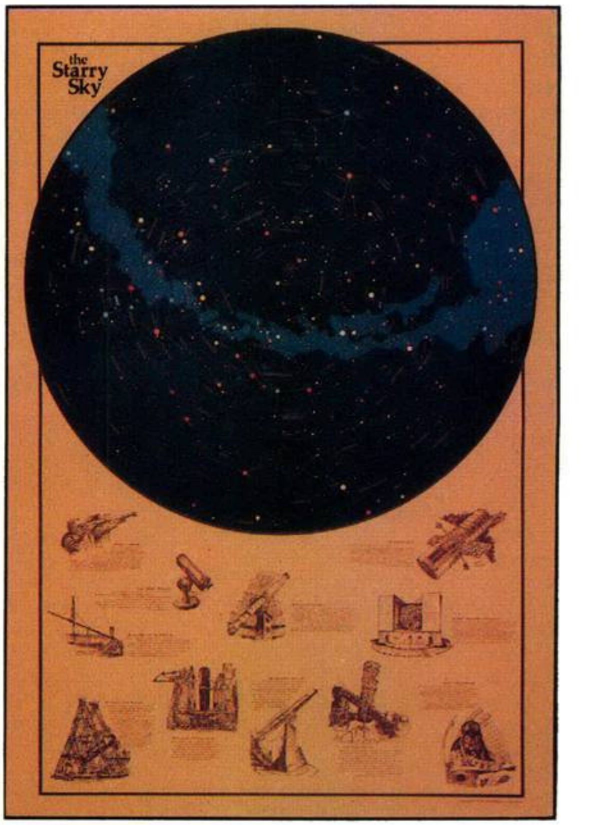

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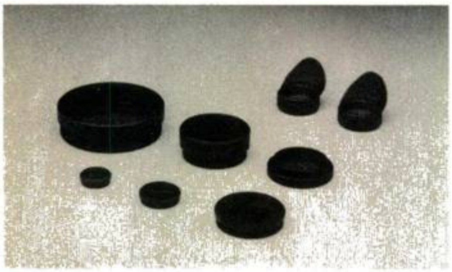
THE WARM, SUMMER EVENING STAR GAZING SEASON HAS ARRIVED!

FIGHT LIGHT POLLUTION WITH LPR FILTERS

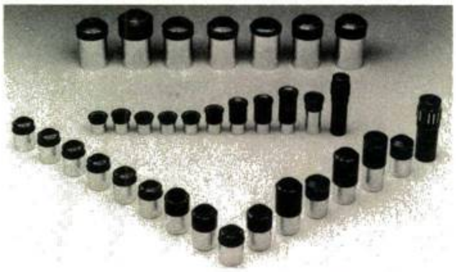


SEE EMISSION NEBULAE WITH MORE CONTRAST

The Summer Milky Way is littered with the places where stars are born—emission nebulae. These fantastic clouds of dust and gas are often seen in photographs as glowing red clouds of dust and gas. City lights make emission nebulae hard to see; so Celestron has developed computer-designed, high efficiency **Light Pollution Rejection** (LPR) Filters. These filters increase contrast by rejecting the light emitted by city lights (both Sodium and Mercury Vapor). Get our accessory catalog for more information. Seven models are available:

Model #1—for C8, C5, C11, C14—visual and photographic use
Model #2—for C11, C14—visual and photographic use
Model #3—for 0.96″ diameter eyepieces
Model #4—for 1¼″ diameter eyepieces
Model #5—for 2″ diameter eyepieces
Model #6—for Celestron Giant Binoculars
Model #7—for deep sky photography

ERFLE EYEPIECES



SUPER WIDE ANGLE, LOW-POWER EYEPIECES

In the photo above is Celestron's entire line of eyepieces. We have 34 of them, one for every application. Complete details can be found in our accessory catalog. The best eyepiece design for deep sky observing and terrestrial viewing is the Erfle. Celestron Erfles are offered in focal lengths of 16, 20, 24, 28 and 32mm in the 1¼″ barrel diameter. Erfle eyepieces have huge apparent fields of view, larger than most Plossl designs. Celestron eyepieces are anti-reflection coated and have baffled interior to assure the highest possible contrast. The longer focal length Erfles give such wide, bright fields of view and have such huge eye reliefs that you'll never want to use shorter focal length oculars on deep space objects again!

MULTIPLE OCULAR HOLDER—.96″, 1¼″

CONVENIENTLY HOLD FOUR EYEPIECES AT ONCE

As you pursue your hobby of astronomy, it is very common to collect eyepieces. A very easy way to hold four eyepieces (oculars) on your Celestron at one time is Celestron's Multiple Ocular Holder (MOH) and rotate the eyepiece you wish to use into position. Now, only a simple twist is required to change from wide angle eyepieces to higher power oculars for close-up examination. Imagine, no more fumbling in the dark looking for misplaced eyepieces! The Multiple Ocular Holders are available for 0.96″ and 1¼″ barrel diameter oculars.

CELESTRON® OWNERS PHOTO CONTEST —

FINDERSCOPES FOR YOUR CELESTRON

LARGER FINDERSCOPES MAKE FINDING OBJECTS EASIER

A larger finderscope makes locating faint deep sky objects (galaxies, star clusters, etc.) easier. Celestron offers right angle finderscopes also for those observers who wish more comfort when trying to locate objects through a finderscope. Field of view data and other details can be found in Celestron's new Accessory Catalog. Finderscopes offered:

1) 5x24—Standard on C90's and C5's
2) 5x24—Right Angle
3) 6x30—Standard on C8, optional on C5
4) 6x30—Right Angle
5) 8x50—Conventional Right Angle or Straight for C8, C11, C14
6) 10x40—For C8 (standard on C11, C14)
7) 10x70—For C11, C14—a super finder!

CELESTRON LENS CLEANING KIT

OMIT
Celestron

KEEP YOUR EYEPIECES AND OPTICS CLEAN

Keep your eyepieces and other optics clean with Celestron's Lens Cleaning Kit. This kit includes instructions, lens cleaner that has been tested on Celestron's mirrors, eyepieces and corrector plates. The kit also contains a can of Omit (clean compressed air) and instructions for cleaning the optics of your telescope. The best advice for keeping your optics in their best condition is to keep them from getting dirty. But, the air is dusty and people leave fingerprints, so it's best to be prepared and have the correct tools to clean your Celestron properly!

Also included is special lens tissue.

DEW CAPS/LENS SHADES

HELP PREVENT DEW FROM RUINING YOUR OBSERVING

Anytime of the year when you observe in cool, damp air the possibility of dew forming on the corrector plate of your Celestron exists. One way to prevent dew from fogging your corrector plate (thereby acting like a diffusion filter) is to use a Celestron Lens Shade/Dew Shield. The Dew Shield protects the corrector plate from dew depositing on it. Another big benefit of the Celestron Dew Shield is that it also shields the front of the telescope from scattered light—if you observe terrestrial subjects this means you'll get higher contrast views and any photographs will be of higher contrast. Celestron has Dew Shields for the C90, C5, and C8.

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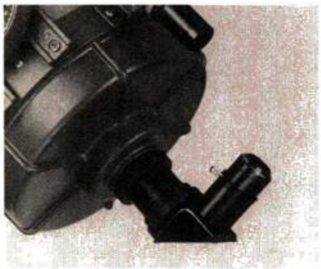
CELESTRON ACCESSORY CASE

KEEP ACCESSORIES CLEAN AND WELL PROTECTED

Celestron offers an accessory case that measures 13½" x 10" x 5½". The Celestron Accessory Case is molded from black polyethylene and comes lined with foam in both halves. The lower half of the case has foam that's die cut so that you can remove small rectangles of foam to fit the accessories you wish to store in your accessory case. The Celestron Accessory Case has latches that lock securely, unlike other molded cases we've seen, so your eyepieces and other accessories will remain clean, organized and well protected.

RICH FIELD ADAPTOR (RFA)



GIVES THE WIDEST POSSIBLE FIELD OF VIEW

Many people want to observe large faint objects in the nighttime sky. For such observations a low power and wide field of view on your Celestron is very helpful. You can use the Celestron Erfle oculars for such observations; but, for the widest field of view you can get with your Celestron telescope use the RFA, the Rich Field Adapter. The RFA comes with our Tele-Compressor lens and Celestron's super wide field 20mm Erfle eyepiece to give the widest field of view you can get, even wider than 2" diameter eyepieces! The 2-inch diameter eyepieces offered by Celestron give slightly higher image quality at the edge of the field of view but the RFA is about half the price and even wider.

DELUXE LATITUDE ADJUSTER—C5/C8/C90

GREATLY REDUCE SET-UP TIME OF YOUR CELESTRON

Celestron offers a Deluxe Latitude Adjuster kit that is really two accessories in one. First, with the Celestron Deluxe Latitude Adjuster, you get a heavy duty, single screw adjustment to vary the tilt of the wedge on your Celestron Astronomical Telescope (C90, C5, C8). This is much more rapid than the standard latitude adjuster for polar aligning. Second, with the Deluxe Latitude Adjuster you get large knobs that allow you to bolt your wedge to a tripod and your Celestron to its wedge **WITHOUT** using tools, this speeds the set-up time at least 100%!

— SEE YOUR CELESTRON DEALER

GIANT BINOCULARS FOR ASTRONOMY

ENJOY THE MILKY WAY WITH DEEP SKY BINOCULARS

The bigger the objective (the lens) of any telescope or binocular the fainter the stars you can see. Celestron offers three 80mm diameter binoculars of 11, 20 and 30 power (11x80's, 20x80's and 30x80's, respectively). You won't believe how many stars in the Milky Way you can see with these binoculars! Binoculars are simply small wide angle telescopes and when you observe alongside a telescope you will find binoculars a tremendous help in locating deep sky objects. The view you'll get with binoculars approaches a 3-D quality and you can spend hours scanning the star clouds of the Summer Milky Way. We recommend a tripod for these binoculars to fully exploit their capabilities. Also, as in any telescope, the *lower* the power, the *brighter* the image; thus, the 11x80's give the brightest images. This is helpful when you are tracking down faint objects. These 80mm binoculars can show you hundreds of objects in the sky at night!

SOLAR FILTERS

NOW IN STOCK

Celestron offers optical glass solar filters. A solar filter from Celestron will show you sunspots, active solar regions and the "granulation" of the sun's surface. With Celestron's proprietary techniques we produce error-free optical windows for our solar filters. We then coat these with Inconel. This offers you a solar filter that shows the sun in ultra high contrast and in natural color, not some filtered tint.

Never look at the sun in any telescope without a solar filter! Eye damage would result. Celestron solar filters are totally safe for viewing and photography. Don't try to project the sun's image without a filter, if you try this old technique with a Celestron you run the risk of heating the baffle tube or optical glass and causing breakage of the optics. The sun is in an active period now, be prepared to view our nearest star in comfort and complete safety with solar filters that are now in stock from Celestron.

MORE INFORMATION

If you want more information on Celestron's Accessories and Telescopes, please write to us.

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ASTRO NEWS

KAO Images Shuttle

On March 30, at the end of the STS-3 mission, an infrared telescope called IRIS (Infrared Imagery of Shuttle) onboard the Gerald P. Kuiper Airborne Observatory (see ASTRONOMY, June 1980) caught an image of *Columbia's* thermal tile heating pattern as the orbiter re-entered the atmosphere.

"We got a beautiful image," said William Ballhaus, director of Astronautics for Ames Research Center. The Kuiper telescope captured one-half of the orbiter, revealing "hot spots" on the wings and temperature gradations.

"It was a tricky mission," Ballhaus said, because the Kuiper crew took off without knowing whether the orbiter would land at White Sands, New Mexico, or Kennedy Space Center in Florida.

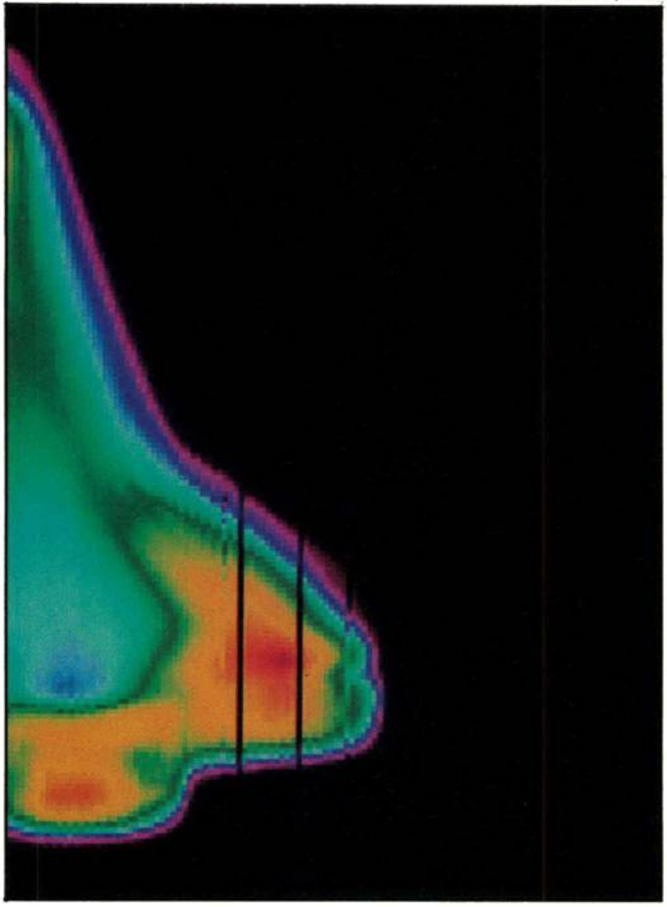
The Kuiper aborted its first mission when the landing was postponed, but the aircraft flew out of Ames again Tuesday at 5:45 a.m. PST. If the shuttle mission ended after orbit 129 at White Sands, IRIS would have a good chance of getting an image. If the shuttle had landed from orbit 130 at Kennedy, the Sun's angle would have prevented the Kuiper telescope from catching it.

A last-minute tracking update 15 minutes before encounter with *Columbia* clinched the experiment's success. The update advised the Kuiper technicians that the shuttle was five miles north of the predicted entry point. The crew made a last-minute change in navigation to put the telescope in position.

The Kuiper captured *Columbia* as it passed through the telescope field of view. After the flight, the infrared data was supplemented by orbiter-derived data on velocity, altitude, angle-of-attack, yaw and roll conditions existing during the period of observation by the IRIS experiment. When it's processed, this data will help in the development of improved thermal protection materials and techniques.

The Kuiper Airborne Observatory is a Lockheed C-141 Starlifter aircraft, equipped with a 36-inch Cassegrain reflector. The scope can be moved in flight over an elevation range of 35 to 75 degrees and track celestial objects to an accuracy of less than two arc seconds with its precision gyroscopes and digital tracking system.

NASA photo



Post-VOIR Venus

Over the past two decades spacecraft have systematically mapped the worlds: the Moon in the 60s, Mars in 1971, Mercury in 1974, Jupiter's moons in 1979, and Saturn's in 1980 and '81. Venus' veil of clouds has kept it off the list, but a radar mission to fill in this blank has become a top priority of American planetary science.

Yet as the Soviets celebrate the landing of their Venera 13 and 14 probes, NASA is scrambling to save its plans to map this world. Earlier this year, the Reagan Administration canceled the agency's Venus Orbiting Imaging Radar (VOIR) mission. Now American hopes for exploring the veiled planet depend on NASA's ability to plan a low-cost alternative.

To an extent, geologists have already begun mapping Venus' terrain. The Pioneer Venus orbiter used a small radar altimeter to reveal 93% of the planet's surface. But the details on Pioneer maps are a hundred kilometers across, so they are more frustrating than revealing. Earth-based radio telescopes have seen features many times smaller — but they can image only 20% of the surface.

While Venus and Earth are virtual twins in size, Venus may have a geology more like the comparatively tiny Moon and Mars. Or it may have a geology similar to Earth in its early stages. Or Venus could have a geology uniquely its own. Any of these make-ups would teach geologists much about how planets form and evolve. The exploration of other worlds, though, has taught them that they won't know what Venus is really like until they get a map that shows at least 70% of the planet at resolutions of one kilometer or better.

To remove the veil from Venus, NASA decided to mount a mission that would image more than the 70% minimum. VOIR's radar would have swept 97% of the planet at 300 meter resolution and selected spots at 75-meter resolution. Geologists would have been able to identify surface features and see enough detail to understand many of the processes that formed them. And VOIR would have done more than just map the planet; it would have studied the gravity field for clues to Venus' interior structure. Five instruments would have examined the atmosphere and ionosphere.

Unfortunately, the price for VOIR came to $700 million, so it took NASA three years to sell the mission to the Carter Administration. Reagan's White House first delayed and then canceled the project. The new administration justified the decision by saying that planetary exploration was past its heyday and other branches of space science like astronomy and astrophysics should receive emphasis. To Washington's new regime, VOIR's price symbolized an inefficient if not wasteful program.

NASA managers realize that VOIR is gone. They believe that any mission burdened with the name — which is a pun on the French verb *voir*, to see — would be rejected. So they call their new effort the Venus Mapper.

"The key to getting the Mapper approved," says John Gerpheide, the project's manager at NASA's Jet Propulsion Laboratory, "is to get the cost down. We believe we can bring it below $300 million; we want to come as close to $200 million as possible. To do that, we must design a totally new mission. The Venus Mapper will resemble VOIR only because both would map Venus."

NASA will cut some costs by meeting VOIR's objectives more economically. When JPL planned the original mission, for example, the synthetic aperture radar (SAR) had stringent requirements. To map the entire planet, the SAR had to be in a low, carefully controlled, circular orbit. New methods of processing the radar's data will allow the Mapper to operate from an elliptical, less carefully controlled orbit.

The effects of this single change ripple throughout the mission. VOIR needed an aerobraking system to use the drag of the tenuous upper atmosphere to pull the spacecraft into the low, circular orbit. The

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Yet, modern production engineering holds the costs to levels that permit our remarkable price of $359.95, complete—not for a "stripped" model, but for the fully equipped RV-6 Dynascope that has won such unprecedented user pride and loyalty. You can order your RV-6 today with complete confidence that it will live up to your expectations in every way, or we will refund every cent you paid for product under our unique 60-day money-back guarantee. Send your check or money order today.

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4. Solid New Equatorial Mount—Precision machined to better than .001", assuring pillarlike stability during observation or long exposure work. No annoying side play or wobble. Solid Stainless Steel Declination axle can never rust, unlike other 6-inch telescopes. Adjusts easily to any latitude.
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8. Strikingly Handsome, White 50" Bakelite Tube with porcelainized Duralite finish, durable yet light. Walls are 1/8" thick, completely insulated and anti-reflective blackened inside. Dimensionally stable, maintains perfect collimation at all times.
9. Brass Rack-and-Pinion Eyepiece Holder has precision-cut worm and gear for easier, smoother, more positive focusing. Takes standard 1-1/4" oculars, negative or positive.
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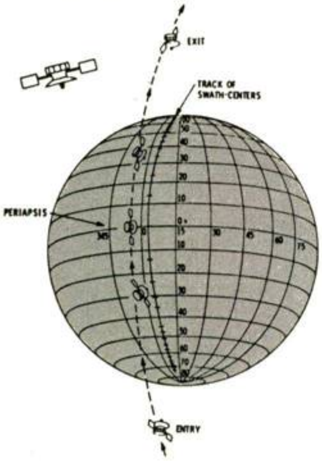
ASTRO NEWS

Mapper won't need this expensive system. Nor will it need the sophisticated pointing system required for VOIR. These changes save tens of millions of dollars.

But to cut costs by more than half, the new mission must simply do less: VOIR would have studied the atmosphere and ionosphere; the Mapper won't. VOIR would have spotted changes in Venus' gravity field between surface locations 300 kilometers apart; the Mapper will spot differences 700 kilometers apart. VOIR would have imaged 3% of the surface at 75 meter resolution; the Mapper will resolve only 300-meter details.

Almost every aspect of the mission will be affected. Some changes are tiny: planning the use of the craft's tape recorders will be cheaper without the atmospheric instruments. Some changes are dramatic: VOIR needed custom-built subsystems to meet its stringent requirements; the Venus Mapper can use standard subsystems. In fact, two-thirds of the craft, by weight, will be made of parts built for other projects.

The current Mapper design incorporates so much leftover Voyager equipment that at first glance the spacecraft looks like the probe sent to Jupiter and Saturn. The two dominant features of the Mapper — the large communications antenna and the octagonal equipment bus — are both spares from the outer-planets mission. A closer look, though, reveals differences. Solar panels, for instance, replace the instrument and nuclear generator booms of the Voyagers.



NASA's proposed Venus Mapper will image from an elliptical orbit thanks to improved SARs.

The mission plan has changed, too. Like VOIR, the Mapper would arrive at Venus in late July of 1988. But VOIR would have lowered itself into a circular orbit and continuously imaged a few-kilometer-wide swath as Venus turned beneath it. The Mapper will remain in a 3.7 hour elliptical orbit that brings it as close as 250 kilometers to the surface and takes it as far away as 10,300 kilometers.

During the 40 minutes surrounding the closest approach on each orbit, the Mapper will point itself at the surface and image a swath 8 to 26 kilometers wide. For the rest of the orbit, the craft will point toward Earth and transmit data. After one Venus day — 243 terrestrial days — the spacecraft will have revealed almost the entire surface.

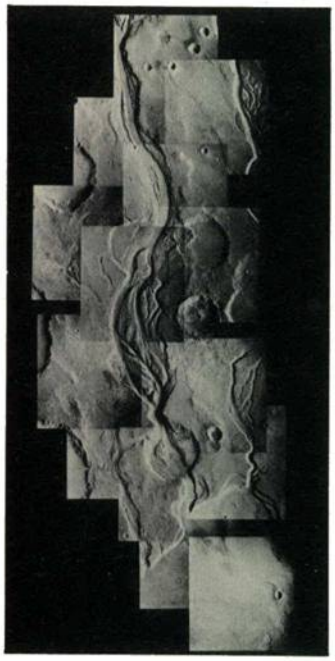
"We're giving up a lot to get the costs down, but we still have a hell of a nice mission," says Steve Saunders who was project scientist for VOIR and now wears the same hat for the Mapper. "The spacecraft will map a planet almost as large as our own. This would be a tremendous gain for planetary geology."

Will it happen? Reagan's people still question the value of planetary exploration, although not as strongly as before. Continued recession or budget deficits will also make the Mapper harder to sell. But the managers of NASA's planetary program hope to get seed money for the project from the 1984 budget, which the administration has just begun to put together.

With a price of $200 million, the chances of approval are probably good; above $300 million the chances rapidly become worse. If the administration refuses to approve the project, NASA can try for a still cheaper alternative. Much of the Mapper's savings, though, comes from simply doing less — if too much more is cut, the mission may not be worth it. In that case, NASA will wait for better economic times to fill in the blank that is Venus' surface.
Van R. Kane.

The Eyes of Viking

More than 50,000 photographs of Mars taken by NASA's Viking orbiters from 1976 through 1980 have been processed at the Jet Propulsion Laboratory.



This sinuous, braided valley on Mars suggests that water erosion occurred during a warmer, wetter epoch. NASA photo

Although Viking 2 ceased operation in April 1980, Viking 1 is beginning its fourth martian year of surface and climate studies and sends back imaging, engineering and meteorological data every week. The lander's radio science investigations also continue. Because a program onboard Lander 1 reconditions each of its four batteries, the lander will continue to operate until December 5, 1994 — barring critical hardware failures.

Scientists at JPL and other research centers across the country continue to study the Mars imaging data. JPL scientists create mosaics from the orbiter images and study channels, volcanos and tectonic features on the martian surface. Results from analysis of photos and other data indicate strong evidence that surface water exists on Mars in the form of ground ice.

Layers in the martian north polar cap appear to hold the key to understanding the climate changes on that planet as they do on Earth. Cloud forms and motion, volatile migration from pole to pole, frost accumulation, and variations in temperature and pressure are also helping scientists understand Mars' seasonal nature.

Viking 1, launched on August 20, 1975, arrived at Mars on June 19, 1976. The Viking 1 Lander separated from the orbiter and landed in the Chryse Planitia region on July 20, 1976. Viking 2 was launched on September 9, 1975 and entered orbit around Mars on August 7, 1976. Its probe landed in the Utopia Planitia region on September 3, 1976.

New Asteroid

A new asteroid that periodically crosses Earth's orbit was recently discovered when Eleanor Helin of NASA's Jet Propulsion Laboratory photographed two components of a rare split comet.

The asteroid, 1982 DB, is a candidate for an asteroid-rendezvous mission under study at JPL and a member of the Apollo family. Apollos are maverick asteroids in orbits outside of the main belt between Mars and Jupiter.

While near-Earth asteroids are potential hazards to Earth, they are also close enough for us to utilize their resources in the future.

1982 DB, one of 34 Apollo asteroids, made its closest approach to Earth in January, when it passed within 2.9 million miles of our planet. The asteroid is especially accessible since it is nearly in the plane of the ecliptic — the approximate plane of the solar system in which planets orbit the Sun.

Helin and Eugene Shoemaker of the U.S. Geological Survey have conducted a systematic search for asteroids and comets at Palomar Observatory for 10 years. They discovered the new asteroid while obtaining a follow-up observation of Comet du Toit-Hartley, which was observed 45 years ago as a single body. The two newly-detected components appeared one degree apart on a single photographic plate. Between them, Helin found the characteristic streak of the "new" asteroid — 1982 DB.

Observations from the Kitt Peak Observatory in Arizona and the Mauna Kea Observatory in Hawaii are underway to determine the asteroid's composition, size and rotational

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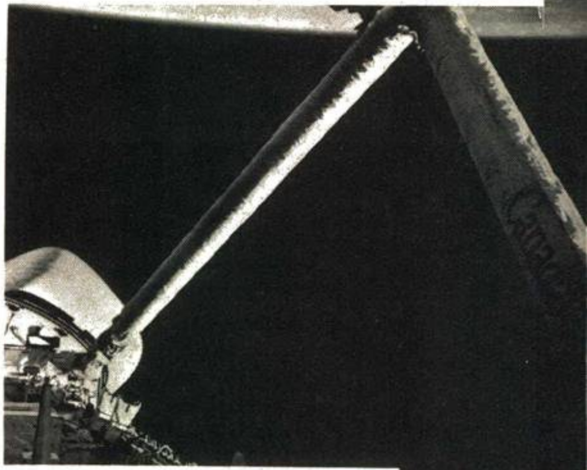

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rate. Its size could range from less than a mile to several miles in diameter.

This asteroid replaces Anteros as a prime candidate for a possible mission to explore and sample an asteroid. According to mission designers at JPL, spacecraft could reach 1982 DB with relatively little energy. The Mariner Mark 2 spacecraft under study at JPL are likely candidates for a low-cost mission to the asteroid.

No Neutrino Mass

In a comprehensive experiment using a Swiss nuclear reactor, an international team of physicists has reported no evidence that neutrinos have mass. The findings, based on work by CalTech physics professor Felix Boehm and researchers at the California Institute of Technology, the Technical University of Munich, and the Swiss Institute of Nuclear Research, represent another chapter in this scientific controversy.

Neutrinos are subatomic particles dubbed "ghost particles of the universe" because they zip through solid matter, including objects as large as planets, as if it didn't exist.

The belief that these particles had no mass was challenged in 1980 when Frederick Reines of the University of California at Irvine sought to establish that neutrinos undergo oscillations from one form to another. According to well established theories, only particles with mass undergo oscillations.

Boehm's search included the tests from the previous experiments, but yielded no evidence for mass. However, he pointed out that a 1980 Soviet study of the decay of tritium did indicate neutrino mass. The results of that experiment have not been challenged.

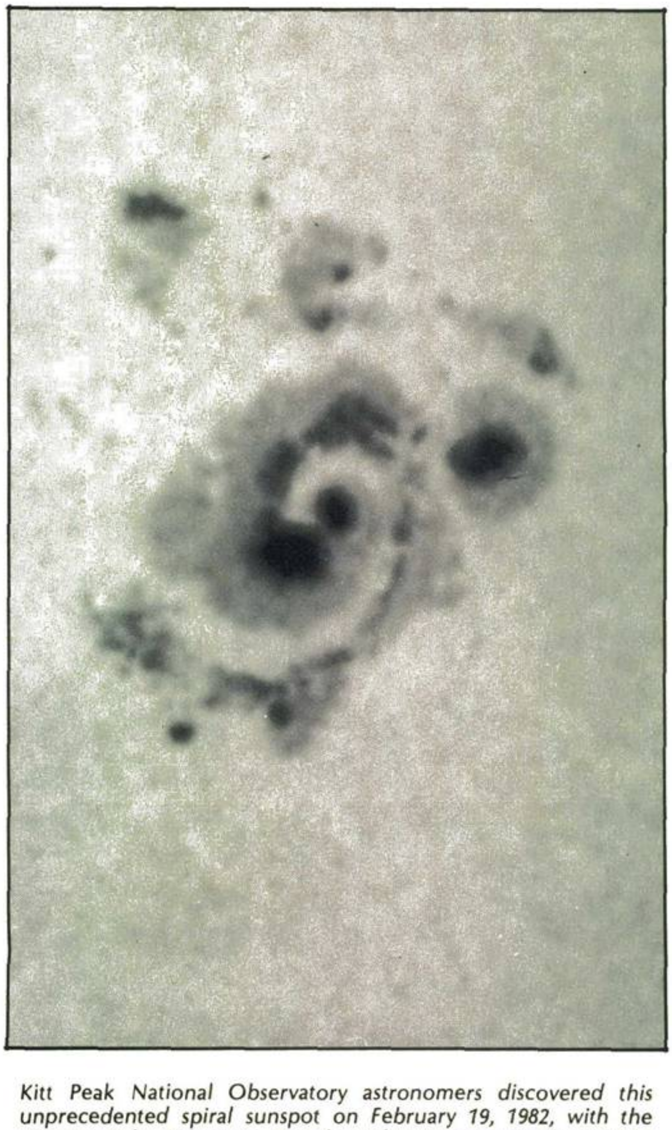
Neutrinos come in three forms — electron, muon, and tau neutrinos. Boehm's experiment searched for electron neutrinos. By comparing the detected electron neutrino spectrum with the version they expected, the scientists could determine whether reactor core neutrinos undergo oscillations.

The discovery of neutrino mass would have profound impact on physics and astronomy. Even a tiny neutrino mass would greatly increase the calculated mass of the universe and could settle the long debate over whether the universe is open or closed.

A neutrino with mass would also supply the "missing mass" in galaxies. Astronomers have long been puzzled by observations indicating that galaxies of billions of stars appear to have far less mass per light emitted than do individual stars. Similarly, individual galaxies possess less mass per light than do clusters of galaxies. If neutrinos have mass, they would supply the invisible mass that had been captured by the greater gravitation of galaxies or clusters of galaxies.

The discovery of neutrino oscillation could explain "the mystery of the missing solar neutrinos," which baffles solar physicists. Counts of neutrinos streaming from the Sun have been well below the number predicted by theories of solar processes. These missing neutrinos could mean that there are serious flaws in physicists's understanding of our Sun's thermonuclear fires. If neutrinos oscillate, they might be changing to an undetectable form on their trip to Earth.

Neutrino oscillations could also impact particle physics, raising fundamental questions about the identity and stabililty of particles. Physical theory holds that neutrino identity — called "flavor" — does not change, and neutrino oscillations could cast doubt on the validity of this concept.



Kitt Peak National Observatory astronomers discovered this unprecedented spiral sunspot on February 19, 1982, with the Vacuum Solar Telescope. It is the only sunspot ever observed to exhibit this structure. KPNO photo

New Comet Model

The conventional model for the structure of a comet is the well-known "dirty snowball" originated by Fred Whipple in the 1950s. It says that comets are low-density frozen volatiles that contain dust. Some of these volatiles vaporize when the comet passes near the Sun's warmth. Solar radiation pressure and the solar wind drive away particles, producing the tail.

Thomas C. Van Flandern of the U.S. Naval Observatory in Washington, D.C. proposed a radically different model in a recent issue of *Icarus*. He says comets consist of an asteroid-like nucleus several kilometers in diameter surrounded by numerous satellites ranging in size from dust particles to objects close to the size of the nucleus itself. As did Whipple, Van Flandern also suggests that a comet possesses frozen volatiles which vaporize when it comes near the Sun.

Though unusual, such an aggregation of loose particles, fragments, and satellites would be stable. The comet's sphere of gravitational influence — inside which the comet can retain satellites — is usually about 100 times the nuclear diameter. This holds true even for very small objects only a few meters across.

But the size of the sphere of influence depends on the comet's distance from the Sun. Close to the Sun, it is small because the Sun's gravity pulls the outer pieces away from the rest of the comet if they stray too far. But at great distances from the Sun, the sphere of influence can be quite large — unless the comet passes close to a large planet like Jupiter, which can also shrink the sphere of influence.

Van Flandern claims this model fully explains observed cometary characteristics. For example, the coma of a comet, its "head," becomes smaller as it approaches the Sun. According to the satellite model, this is due to the shrinking sphere of influence as the comet nears the Sun. As the comet's sphere of influence

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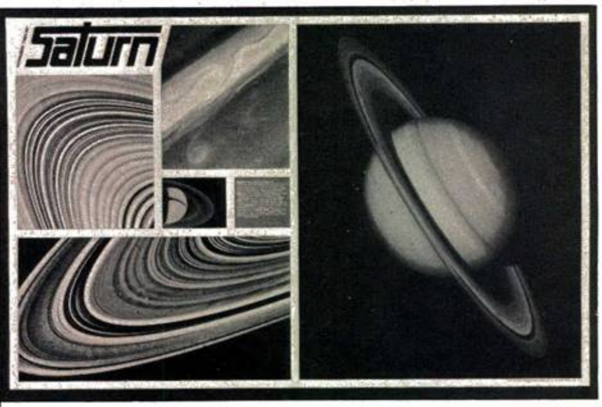

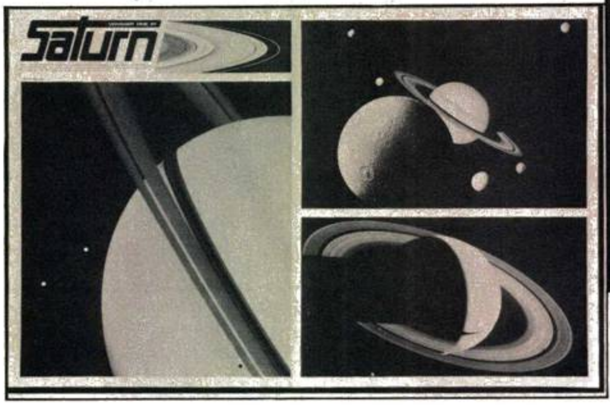

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ASTRONEWS

shrinks, the comet loses its outer satellites and so the coma appears smaller.

Van Flandern's model also deals with the case of new comets — those which are thought to be making their first approach to the Sun. These are dimmer after they have passed perihelion. Periodic comets, on the other hand, look about the same before and after perihelion passage. Van Flandern says this happens because a new comet's sphere of influence shrinks for the very first time in its life — which lets its outer satellites escape. Periodic comets have already lost all they can lose on previous passages by the Sun. Unless their perihelion distance decreases, they should not lose many more satellites and will continue to look the same.

This model also could explain the splitting of comet nuclei as "the wandering-off of one or more of the larger orbiting satellites as they move outside the sphere of influence of the nucleus for the first time as the comet approachs the Sun." Obviously, splitting should then occur only when the sphere of influence is shrinking — when the comet is approaching the Sun, rather than receding from it. Van Flandern claims that past observations of splitting comets support this.

Van Flandern warns that his model implies a much greater danger for comet flyby missions than does the dirty snowball model. Because the spacecraft may collide with some of the wayward satellites, he recommends that, if posssible, important experiments be performed long before closest encounter.

"The satellite model is in better agreement with the observed characteristics of comets than is the dirty snowball model or any of its current variations," agrees Van Flandern. He points out the similarities between asteroids and comets, saying they both tend to be carbonaceous. In addition, he cites studies showing that some comets reflect only about 10% of the light hitting them. This is similar to asteroid reflectances but "unexpected," he says, if comets are icy. He suggests asteroids are simply comets which have used up their supply of volatiles and dust from repeated exposures to the Sun.

Van Flandern is one of the champions of the controversial idea that many asteroids possess satellites. His new comet model, calling for cometary satellites, is likely to prove even more controversial. *Ken Croswell.*

ASTRO CALENDAR

July 16-18.	**Connecticut River Valley Astronomers Conjunction.** Northfield Mountain Center, Northfield, Massachusetts. Contact: Jack Megas, 311 Surrey Rd., Springfield, MA 01118
July 16-19.	**International Student Space Conference,** sponsored by Students for the Exploration and Development of Space. Washington, D.C. Contact: SEDS Conference, 800 21st Street, P.O. Box 24, Washington, DC 20052.
July 16-24.	**National Spaceweek.** Needs local organizers. Contact: Spaceweek National Headquarters, P.O. Box 58172, Houston, TX 77058.
July 16-24.	**Florida Spaceweek '82.** Various cities. Contact: Florida Spaceweek Committee, 993 Macco Road, Cocoa, FL 32922.
July 18-August 8.	**International Workshop for Amateur Astronomers** (I.W.A.A.). Havelte, The Netherlands. Contact: Niels van Weersen, Sand-Ambachstraat 17, 2691 BL 's Gravenzande, The Netherlands.
July 21.	**24th Annual Summer Science Program in Astronomy.** Ojai, California. Contact: Roger D. Klauscer, Thacher School, Ojai, CA 93023.
July 21-24.	**ALCON '82** — national convention of the Astronomical League including ALPO, IAPPP, IOTA and National Deep Sky Observers annual meetings. Peoria, Illinois. Contact: ALCON '82, P.O. Box 5203, Peoria, IL 61601.
August 11-13.	**IAPPP Springfield Meeting.** Hartness House, Springfield, Vermont. Contact: R.C. Wolpert, 144 Neptune Ave., N. Babylon, NY 11704.
August 14-17.	**Stellafane.** Springfield, Vermont. Contact: Dennis di Cicco, 60 Victoria Road, Sudbury, MA 01776.
August 17-26.	**XVIII General Assembly of the International Astronomical Union** (professional meeting). University of Patras, Greece. Contact: Organizing Committee, General Assembly IAU, University of Patras, Patras, Greece.
August 27-29.	**Western Amateur Astronomers (WAA) 1982 Convention,** "Focus on Astronomy." Contact: Ames Research Center, Moffett Field, CA 94035.
Sept. 24-26.	**AstroFest.** Chicago Astronomical Society telescope fair and conference. Kankakee, Illinois. Contact: AstroFest, P.O. Box 596, Tinley Park, IL 60477.
October 4-6.	**Technology for Space Astrophysics, the Next 30 Years.** Co-sponsored by AIAA, SPIE, OSA. Danbury Hilton Conference Center and Inn, Danbury, Connecticut. Contact: Norman Geril, Perkin Elmer Corporation, 100 Wooster Heights Road, MS 879, Danbury, CT 06810.
October 9-12.	**Conference on Lunar and Planetary Volatiles.** Lunar and Planetary Institute, Houston, Texas. Contact: Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058.
October 13-16.	**18th Conference of the Great Lakes Planetarium Association.** Lakeview Planetarium, Peoria, Illinois and I.S.U. Planetarium, Normal, Illinois. Contact: Carl J. Wenning, Department of Physics, Illinois State University, Normal, IL 61761.
November 12-14.	**Space '82 — British Interplanetary Society.** Piccadilly Hotel, London. Contact: Executive Secretary, British Interplanetary Society, 27-29 South Lambeth Road, London SW8 1SZ.
November 15-18.	**Chondrules and their Origins.** Lunar and Planetary Institute, Houston, Texas. Contact: Pamela Jones, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058 or Albert King, Department of Geosciences, University of Houston, Houston, TX 77004.

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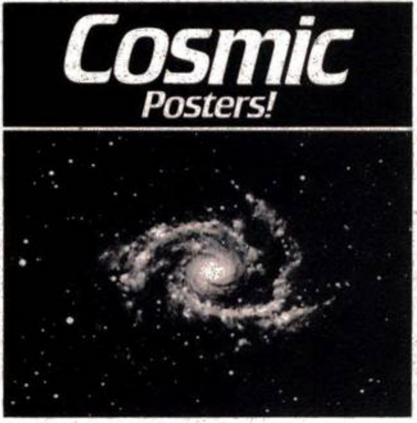

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WANTED — Tax-deductible contribution of astronomical quality telescope and photographic equipment and visual aids for 4-H youth educational program. Will pay for freight. Contact John Wagenknecht, Youth Development Advisor, University of California Cooperative Extension in Napa County, 1436 Polk St., Napa, CA 94558. Phone (707) 253-4221.

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STS-3

"It's a real barn burner." Commander Jack Lousma 00:03

A Space Shuttle launch is a singular experience — the ultimate media event. More than 2,000 correspondents from around the globe converge on Merritt Island, a wildlife refuge and home of the Kennedy Space Center, to see the newest dream for space industrialization hurtle into orbit. A million spectators jam the highways outside the base perimeter; they come from around the country to see man's leap into space.

We arrived at Kennedy Space Center on Wednesday, March 17, for the launch of STS-3 scheduled for the following Monday. After we found the accreditation center, we checked in and received our credentials. NASA gave us a vehicle pass and a pass for each person. The public information officer warned us not to lose our badges since it could mean a lengthy stay with military security. Although the chances of sabotage are small, NASA is serious about enforcement.

When we reached the press grandstand and media center, 3½ miles from the launch complex, the gantry seemed small. The enormous Vehicle Assembly Building, large enough to hold four Empire State Buildings, loomed across the street. A new geodesic dome housed a "command center" where visiting journalists relaxed or composed stories. Custom phone and data access terminals, desks, TV monitors, and amiable public information officers made the reporters' job easier. A rack on the wall was full of press releases — background and latest developments. NASA offered special tours, and we chose from wildlife outings to tours of abandoned launch facilities.

Three days prior to launch the pace quickened, and press crews arrived every hour on a heliport adjacent to the grandstand. The three national TV networks hooked up satellite communication dishes next to their permanent structures while the grandstand crowd ebbed and flowed with those who watched closed-circuit news reports and interviews. TV and audio monitors were mounted everywhere; you couldn't help but hear the latest updates.

For photographers, the last days were hectic, since NASA offered three major photo opportunities. The first was a tour of the entire Center. On Friday, March 19, NASA loaded five buses with photographers and shuttled them to various parts of the base. Not all media representatives went on this outing; some had already taken the tour at the STS-1 and STS-2 launches.

The next photo shoot was scheduled for sunset, and everyone signed up for this spectacle. The Sun set rapidly across Florida's flat land, and as we approached Perimeter Road, it dipped into the horizon clouds, the last crepuscular rays escaping. The buses stopped, and one thousand photographers jumped off fighting for prime spots. As the sky darkened, banks of Xenon floodlights came on one at a time, illuminating the launch area. Breathtaking sunset colors and pristine floodlighting combined to produce an awesome background for pictures.

After 20 minutes of shooting from one angle we took a short ride to a face-on view of the Shuttle flanked by its Solid Rocket Boosters. Now the only lighting came from the floods. After another 30 minutes of footage it was over — two days until launch.

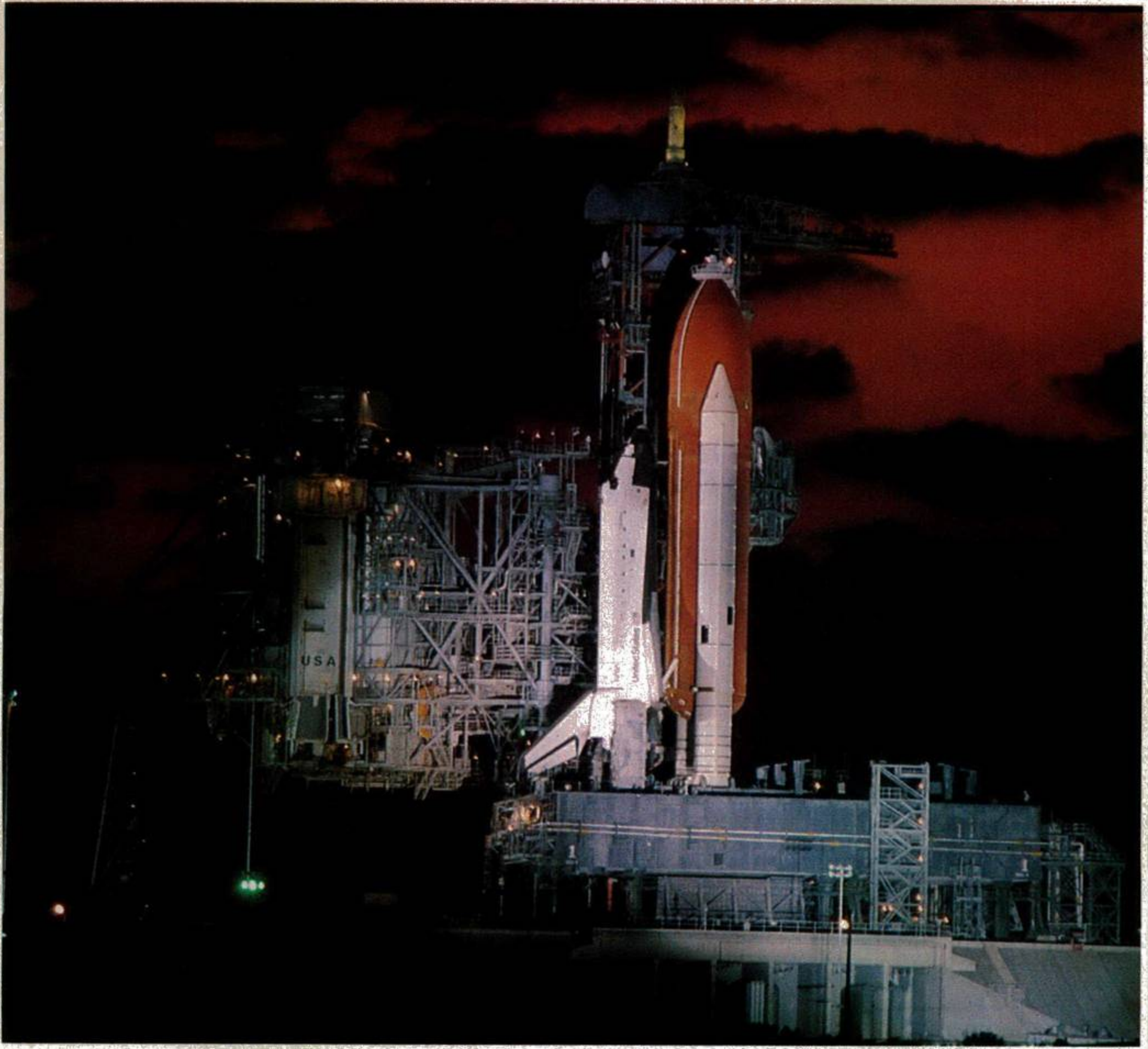
Saturday morning came quickly, and today we would inspect locations for remote controlled cameras. We were closer to launch pad 39-A than expected. Comparatively few photographers had permission to operate remotes, but NASA had given us an official OK several months in advance.

Using remote controlled cameras required extensive planning. We had to set

Right: the ASTRONOMY crew was treated to a striking sunset the first evening we photographed the Shuttle. As the sky reddened, layer upon layer of horizon clouds floated behind Launch Pad 39-A, and banks of xenon floodlights crisply illuminated Columbia.

Center pages: as the red sunset faded, NASA guides took us within 300 yards of Columbia. *From this vantage point more than 500 photographers shot roll after roll of the clearly defined orbiter flanked by the SRBs. Two technicians stand on the base of the Rotating Service Structure to the left of* Columbia.

Lower right: after dark the lights cut a path through the sky that you could see 25 miles away. Launch buffs camping on Florida's highways and waiting for liftoff were treated to a carnival-like sight as they looked across the water toward Kennedy Space Center. The softly lit Shuttle, 3½ miles away, looks tiny even in this photo taken with a 500mm lens from the press viewing area.



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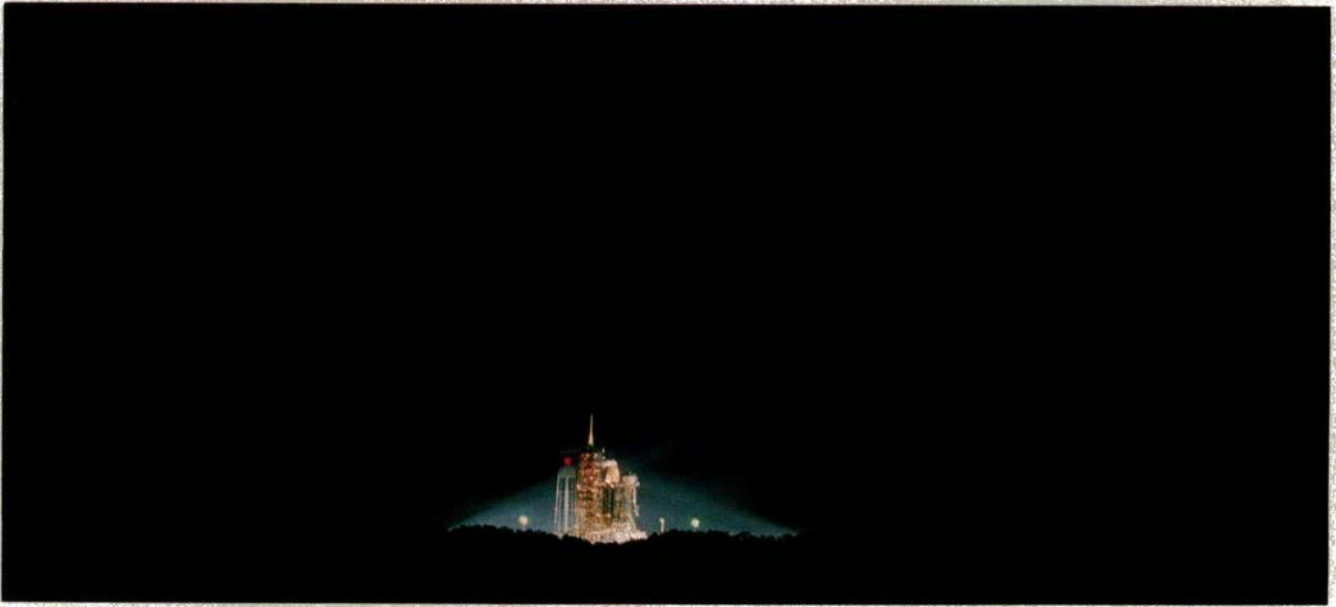

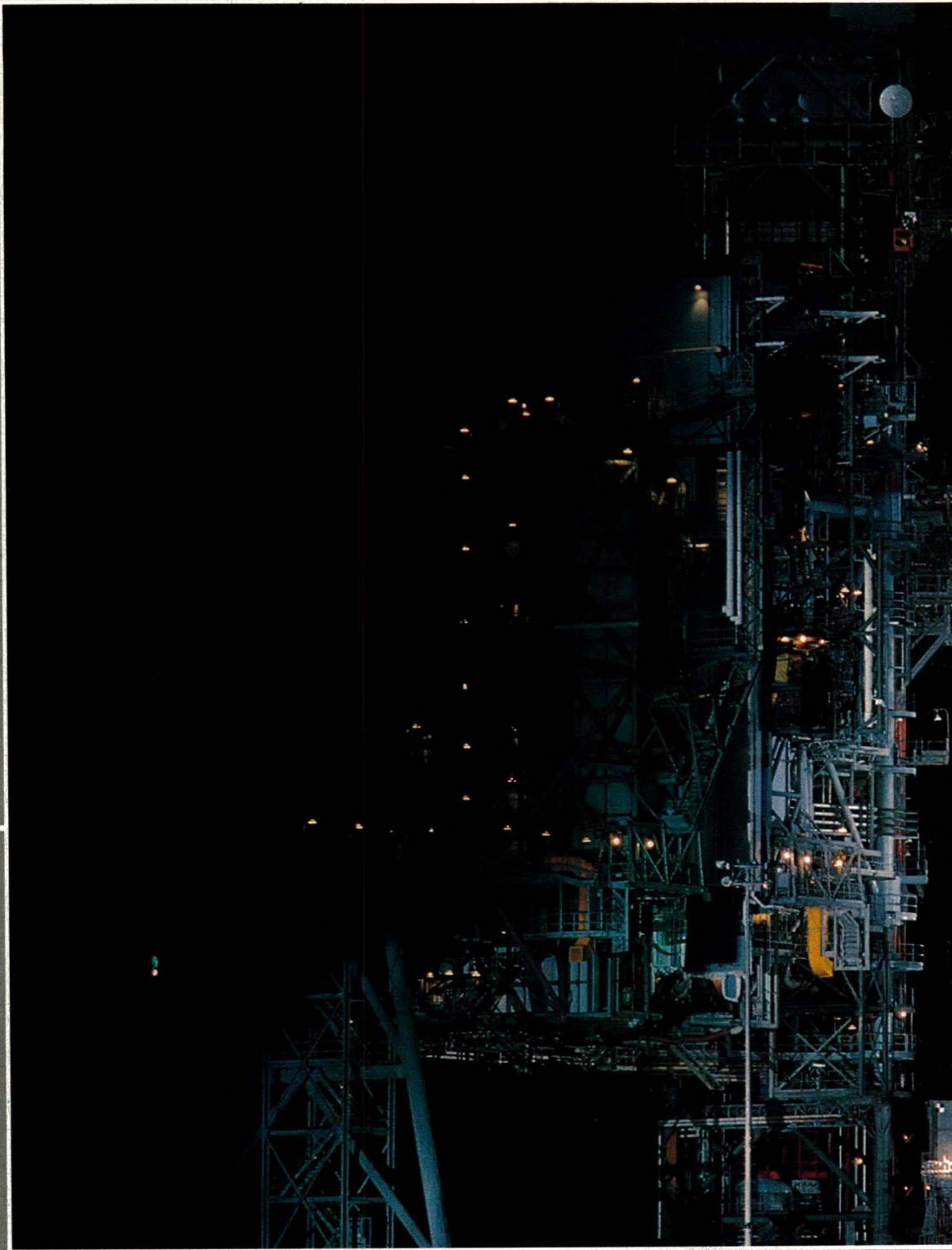

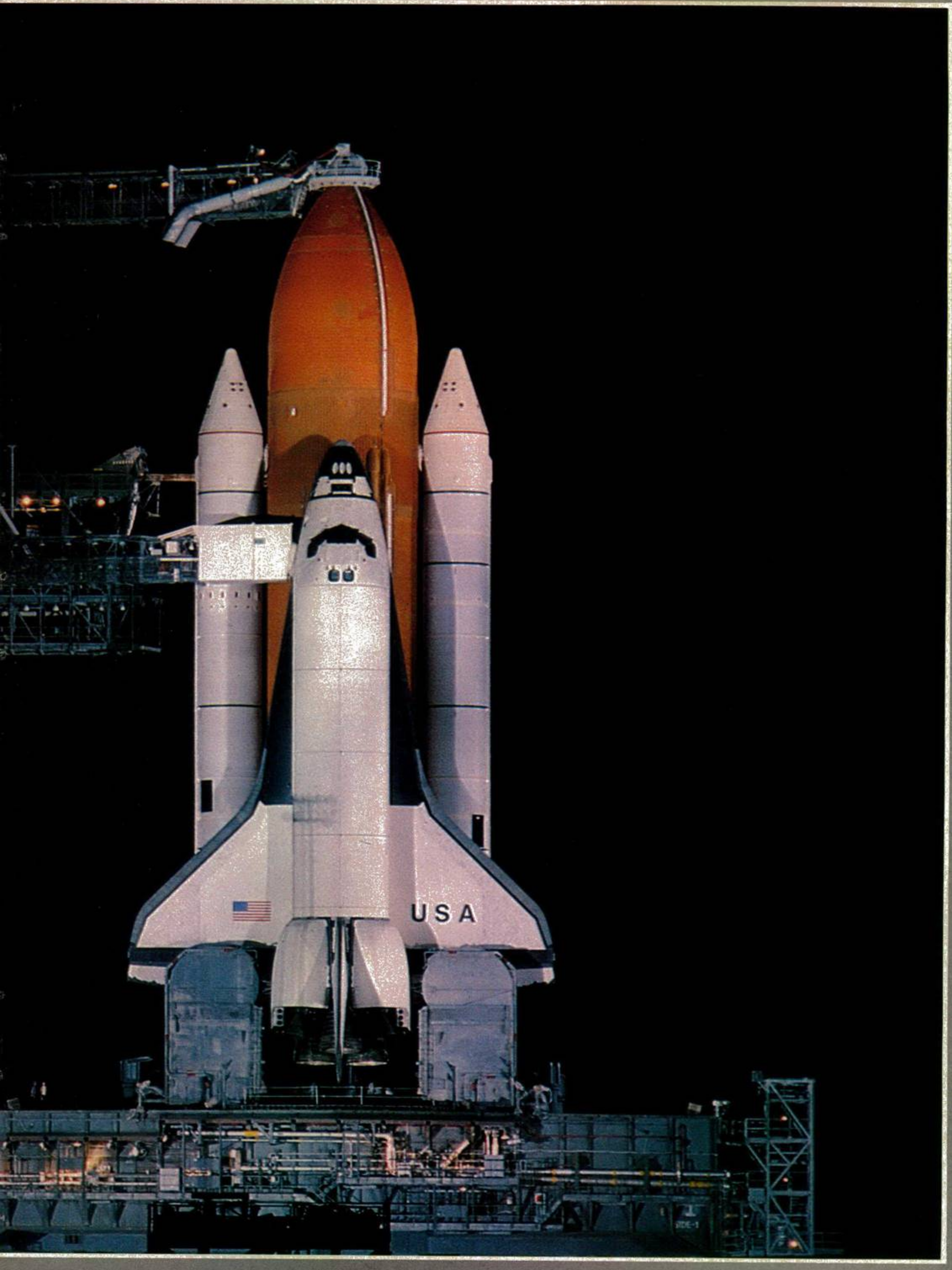
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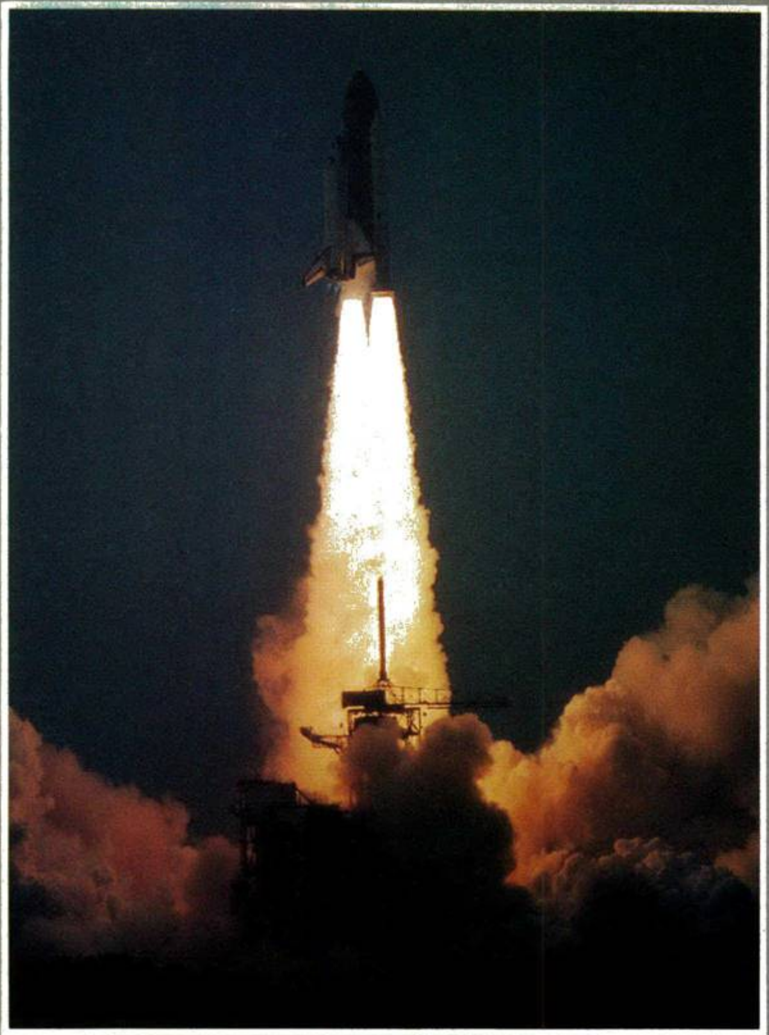
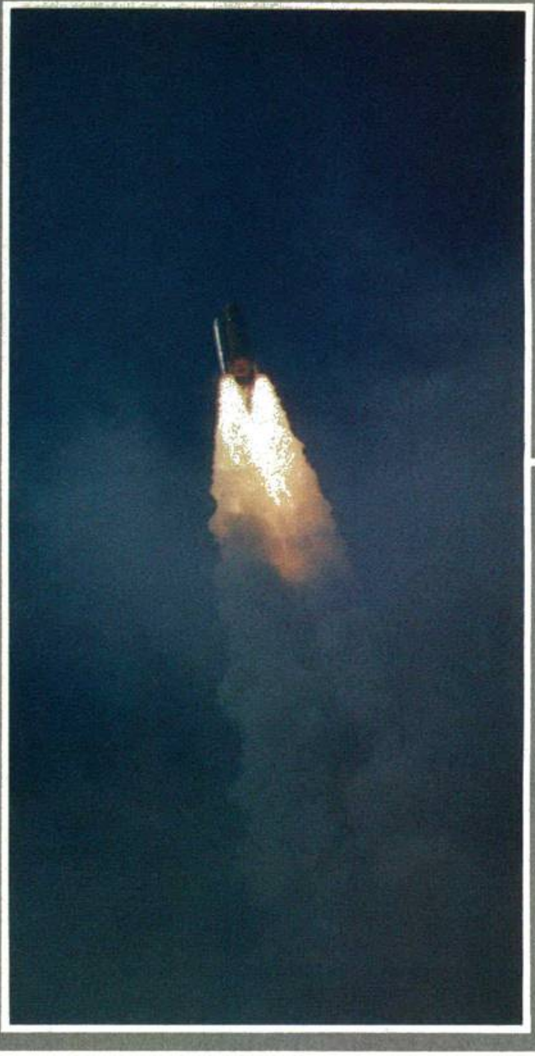
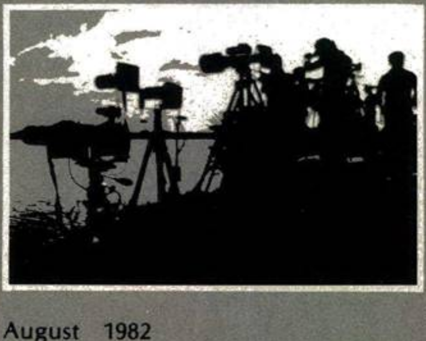




Within seconds of ignition, the Shuttle climbs rapidly away from Earth and accelerates so quickly that you must move fast to keep it in the viewfinder. Low-lying cumulus clouds obscured our view moments after Columbia cleared the top of the gantry, and though we tried to guess where the Shuttle might pop out, we lost sight of her for a second or two. Columbia re-emerged as a tiny speck belching a tail of fire and climbing away into the blue Florida sky.

Far left: heat rising off the Florida ground produces turbulence in the atmosphere, and a telephoto only magnifies this distortion. Still, a 500mm lens and a motordriven camera can record breathtaking footage from the press area though you shoot across several miles of open water.

Columbia climbs skyward just moments after ignition in this wide-angle view taken by a remote-controlled camera 900 feet from the launch pad. If you stood this close during a launch, the 160dB blast would shatter your eardrums. When we retrieved our cameras, they were covered with particulate matter and droplets of hydrochloric acid that formed when the rocket propellants combined.



them up 36 hours before launch, but we couldn't predict the weather. And at lift-off, the sound pressure levels would exceed 160dB, and ejecta would pepper this area. Protection and realiability were paramount. NASA told us that Saturn V launches had blown over many remote cameras, but Shuttle launches were not as severe.

On Sunday, with less than 24 hours until lift-off, we set up our remote gear on the spots we had chosen Saturday. Hourly bulletins reminded us that NASA engineers were hurriedly reviewing their own checklists. The big chronometer on the edge of the press area noisily clicked down the minutes.

At noon the buses rolled back into the parking lot. This time NASA couldn't fit many photographers to a bus because everyone carried several hundred pounds of shelters, sandbags and tape. Each photographer had at least four cameras. Some crews brought plywood and plexiglass structures to protect their cameras from nasty weather and the launch blast. We had four hours to prepare and test our cameras. Imagine lugging heavy equipment through sand in 95° temperatures.

The key to operating the remote cameras was not radio or restricted wavelength light — NASA doesn't allow these since stray electromagnetic waves can affect their equipment. We had a choice between a sonic trigger activated by the main engine ignition, or motion sensors that would trip the shutter when the ground shook. Both have merit, but what if a surveillance jet flew too close to our cameras and set them off before launch? Or maybe our motion sensors would be too sensitive, and a wind-blown twig would trip them. It was a gamble, but we chose sonic triggers set to a predetermined decibel level. As we boarded the bus, our unseeing cameras sat high atop a sand dune, waiting for ignition.

Sunday night came, and we grew restless with nothing to do except wait until morning. The crowd had grown considerably since Wednesday, and journalists from the world's major media had arrived. The parking lot was full of recreational vehicles, and tents sprouted next to tripods as the Sun dipped below the horizon and brought a cooling rush of air. Helicopters crisscrossed the twilight sky, and a cacaphony of loudspeaker announcements, conversation, and the drone of aircraft produced an unsettling din. On the night before a launch, the future is not around the corner — it's at Kennedy Space Center.

We finally tired of fighting off the clouds of ravenous mosquitos, and pulled out our sleeping bags. Inside them we were safe from bites, but the temperature quickly rose and became unbearable. It was a poor trade and sleep seemed out of the question, so we gave up and walked around the complex, checking that everything was still on schedule. At 4 a.m. hardly anyone was asleep. Small groups of journalists traded stories; others just sat and waited.

Finally the sky brightened, but the mist over the water dimmed our view of the gantry. Through a telephoto lens, 3½ miles of turbulent atmosphere distorted the Shuttle's image. It swam in and out of focus as heat currents rose off the water. We prayed for the Sun to burn off the mist, but low lying sunrise clouds compounded the haze and made conditions bad for photography.

People around us rose slowly from their brief slumber. Helicopters were still buzzing, and one hovered close-by as it filmed the waking press. Scores of photographers spent the night on the small bluff overlooking the water, sleeping next to their cameras to prevent any trickery, but the night passed without incident. Camera calibrations and adjustments as well as a pre-launch anxiety filled our thoughts. The big question was: Will it go?

T-minus 30 minutes: Final preparations were frantic. More than 1000 people had set up their cameras behind us. We had cramped quarters on the front row even though we were there first and had one of the largest spots. The haze parted slightly, but the magnified view was still distorted. Time ticked by quickly as the final countdown approached, and we thought about those remotes 900 feet from a roaring tower of flame. Would they go off at the right moment? At least we had other cameras in front of us, and their settings were locked to prevent mistakes. We kept close watch on the rocket's bottom, and finally saw a puff of smoke as the solid rocket boosters ignited. Then we saw flames as the main engine fired. A few seconds later the sound reached our ears.

The Shuttle sat motionless on the pad for three seconds, climbed a bit, and then leaped rapidly away from the gantry. The crowd roared along with the rocket, and the whirr of camera motordrives filled our ears. The Shuttle pierced a low-lying bank of clouds and we lost sight of it. When it punched through the top, it was downrange and tiny, even with the magnification of a telephoto. We squeezed off the last few frames as it headed out of the atmosphere and into orbit atop a towering plume of smoke, steam, and flame.

We had spent five days preparing for six seconds, but NASA engineers had waited years to see if this experimental vehicle worked. They knew what it meant for humanity, so they fought through an entire decade to show the world this major feat of engineering. For NASA a Shuttle Launch is more than a spectacular visual sight or a monument to 20th century technology — it is an avenue mankind can take to explore tomorrow.

— Berry Brunk

ASTROMART

WANTED — Correspondence worldwide with people who have seen UFOs. I'm 18, single, would like to hear from girls, photos exchanged. Would also like to learn how to trap nuisance telephone calls. Contact Larry Powell, Box 462, Elmo, TX 75118.

WANTED — Correspondence with new friends, female or male, by 27 year old male. I'm interested in reading, writing, music, and space. Will answer all mail. Contact Walter Bible, P.O. Box 520, Walla Walla, WA 99362.

WANTED — We are in the process of getting an astronomy club started in central Minnesota and can use all the help and advice we can get from other clubs and individuals. Contact David Starkka, 606 South 8th St., Brainerd, MN 56401.

WANTED — Volume 1, number 1 issue of *The Planetary Report*, the Planetary Society's publication. Contact Mike E. Knotts, 2759 Dellinger Dr., Marietta, GA 30062.

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WANTED — Correspondence with people from England, ages 12 to 17, interested in jokes (telling and hearing them), writing, animals, photography, astronomy, and movies. Contact Marc Orlow, 6505 Ventnor Ave., Ventnor, NJ 08406, U.S.A.

WANTED — Lum's *Stars in Our Heavens* or other books on starlore. Especially interested in Oriental, Hindu or American Indian legends. Contact Rick Mark, Box 8D, R.D. 2, Kempton, PA 19529.

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FOR SALE — Schmitt & Associates 5.6" drive gear and worm with heavy duty 300 in/lb motor, best offer; Minolta 3x teleconverter, $30; 1924 Kodak No. 3-A Autographic Classic in fair condition, best offer; 6" f/8 mirror, $20; Criterion 4mm Orthoscopic eyepiece, $15. Contact David Fabrizio, 108 Kenwood Ave., Stratford, CT 06497.

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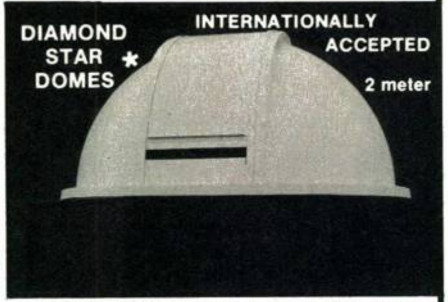

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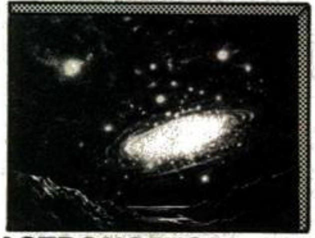

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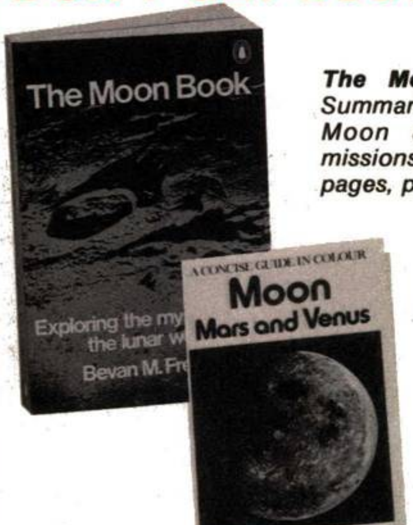

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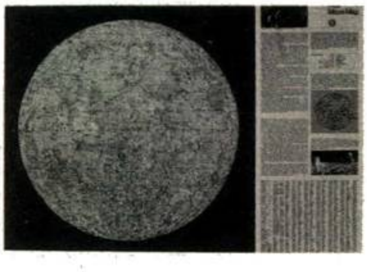

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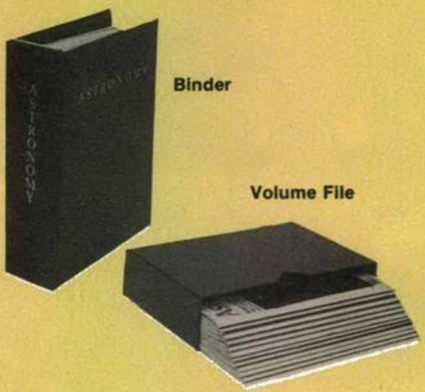

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the backyard astronomer

cygnus

Mercury

During most of August, Mercury will be too close to the Sun to be seen. But in the last week of the month it will appear extremely low over the western horizon shortly after sunset. Mercury will reach greatest elongation to the east on September 6, but despite its 27° separation from the Sun, it will remain very low in the sky. This is the innermost planet's worst apparition this year.

Venus

Venus will halt its northward march along the horizon in the predawn sky and rapidly lose altitude during August. It will be visible in the morning sky for approximately two months more, but will disappear into the glare of sunrise by early October.

Telescopically, Venus is disappointing at present. Since the planet lacks any discernible features, the chief thrill of Venus-watching comes at times near inferior conjunction, when its size and phases are changing rapidly. Its telescopic size is small — 10.8″ of arc on the 15th — and its phase is nearly "full": 93% lit.

Mars

Mars continues its eastward dash along the ecliptic. On the 10th, it will pass 2° south of Jupiter — and complete a perfect grouping for a fine series of photographs with medium telephoto lenses.

Mars experiences its autumnal equinox on August 27. When that happens, Earth will still be above the martian equator by 17°; Earth won't cross the martian equator until October 25, by which time the Sun will be over the martian 14° south parallel of latitude.

Young energetic stars excite clouds of hydrogen gas to shine red. George Briggs captured the elusive nebulosity of the North America and Pelican Nebulae in Cygnus with a 40-minute exposure on GAF 500 film through a 200mm f/3.5 mounted piggyback on his scope. He wins the "Best Astro-Photo Award" for August.

Asteroids

1 Ceres (magnitude 8.3) is in Libra to the east of Alpha (α). Its positions:

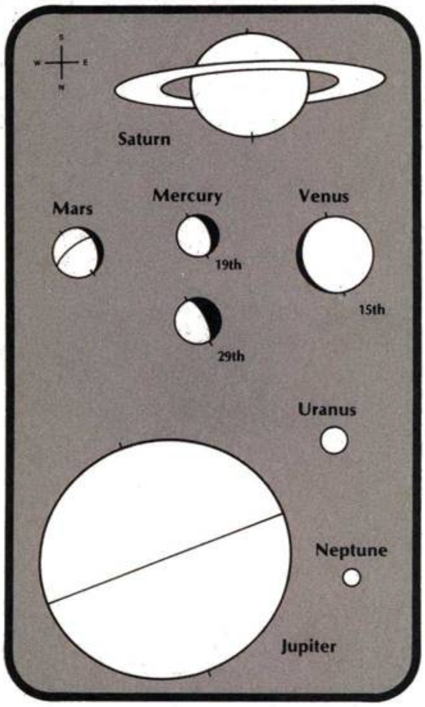
9th: 15h 01m 27s, −11° 41′ 12″
19th: 15h 10m 04s, −15° 52′ 30″

Ceres sets about 11:30 p.m. local daylight time on the 15th.

2 Pallas (9.6) lies in southwestern Bootes. Its positions:

9th: 13h 45m 53s, +15° 25′ 39″
19th: 13h 58m 02s, +14° 03′ 02″

Pallas sets around 11:30 local daylight time at mid-month.



3 Juno (10.4) is in eastern Ophiuchus. Its positions:

9th: 17h 37m 15s, −7° 15′ 07″
19th: 17h 35m 54s, −8° 07′ 57″

Juno sets about 2:00 a.m. local daylight time in mid-August.

4 Vesta (6.1) lies in eastern Capricornus and comes to opposition on the 10th. On the 14th, at 6:36 UT, it will pass 25′ of arc south of the 3.7 magnitude star, Zeta (ζ) Capricorni. Vesta's positions:

9th: 21h 28m 47s, −22° 23′ 33″
19th: 21h 19m 26s, −23° 34′ 54″

Vesta is in the sky the whole night long.

All asteroid positions are in 1950 coordinates.

Jupiter

Jupiter sets earlier each night as our long observing season draws to an end. The gas giant's 27° elevation 45 minutes after sunset on August 1 will drop to half of that by the 31st.

Though you don't have the entire night to watch the planet, your observing skills should be about at their peak — if you've been regularly turning your scope to Jupiter. Now is the time to make the most of them.

Saturn

As Saturn sinks toward the glow of the oncoming Sun, you should be planning to wrap up your saturnian observations. In less than a month this ringed beauty will be too low for clear viewing. We won't see it again until the late fall or early winter when it re-emerges in the morning sky.

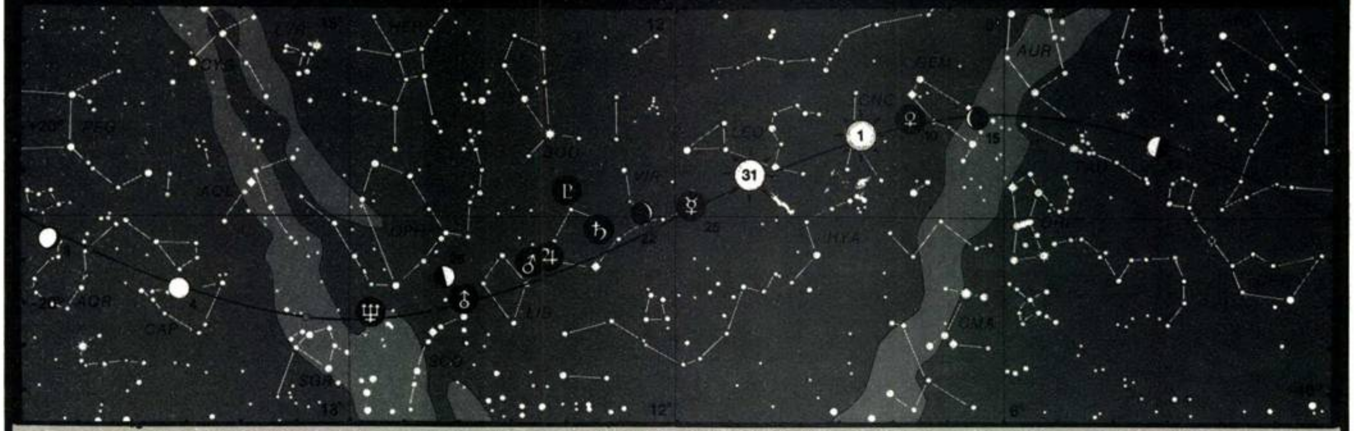
Uranus

Uranus lies in Libra, just over the border from Scorpius. The star closest to it is Lambda (λ) Librae, a 5th magnitude white star. Lambda lies just 1m 30s of R.A. west and 1′ 10″ of arc north of Uranus on August 9, the date the planet is stationary in right ascension. You'll find Lambda by scanning about 12m of R.A west and about 20′ of arc south of the bright double star, Beta (β) Scorpii. Uranus will have a 5.8 magnitude, 3.7″ of arc disk.

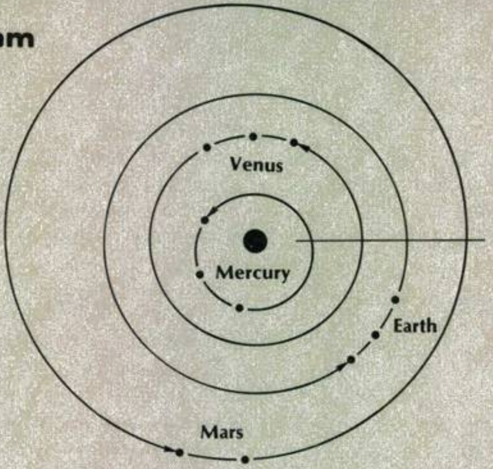
Neptune

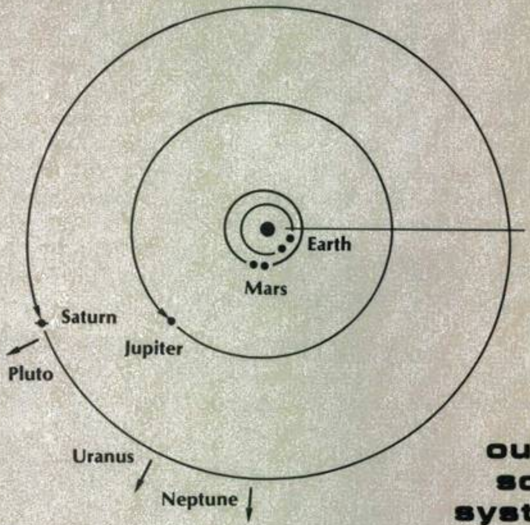
Hidden among the star-clutter at the edge of the Milky Way in Ophiuchus, Neptune has no bright pointer stars to help you find it. Nevertheless, fifth

planetary data august 1982



inner solar system





outer solar system

		Date	Mag.	Angular Size	% Illum.	Distance (AU) from: Earth	Distance (AU) from: Sun	Longitude: Heliocentric	Longitude: Ecliptic	R.A. (1982.7)	Dec
Sun		1	−26.7	31.6′	—	1.02	—	—	128°26.5′	8h 43.4m	+18°09.4′
		15	−26.7	31.6′	—	1.01	—	—	141°51.5′	9h 36.9m	+14°13.6′
		31	−26.7	31.7′	—	1.01	—	—	157°16.8′	10h 35.9m	+8°50.5′
Mercury	☿	1	−1.2	5.0″	96%	1.34	0.36	157°02.7′	133°14.8′	9h 14.9m	+17°48.7′
		15	−0.2	5.4″	82%	1.23	0.43	210°54.9′	160°24.7′	10h 50.6m	+8°09.3′
		31	+0.3	6.4″	64%	1.04	0.47	257°03.7′	182°59.3′	12h 10.5m	−2°48.5′
Venus	♀	10	−3.3	10.9″	92%	1.54	0.72	82°00.5′	114°07.5′	7h 46.0m	+21°21.6′
		31	−3.3	10.4″	96%	1.62	0.72	115°59.9′	139°49.4′	9h 31.9m	+15°38.5′
Mars	♂	15	+0.9	6.8″	88%	1.38	1.48	258°05.3′	216°20.0′	14h 16.4m	−14°40.2′
Jupiter	♃	15	−1.5	34.9″	99%	5.65	5.42	223°55.8′	213°16.1′	14h 07.3m	−11°46.0′
Saturn	♄	15	+1.1	16.3″	100%	10.29	9.70	203°04.8′	197°39.4′	13h 10.3m	−4°54.8′
Uranus	⛢	15	+5.9	3.7″	100%	18.71	18.90	243°37.9′	240°11.9′	15h 53.9m	−20°08.3′
Neptune	♆	15	+7.7	2.5″	100%	29.71	30.27	266°01.3′	263°58.8′	17h 35.8m	−22°02.1′
Pluto	♇	15	+13.8	—	100%	30.37	29.94	206°24.4′	204°11.1′	13h 55.6m	+6°06.7′

moon data

Full Moon	August 4 at 22:34
Last Quarter	August 12 at 11:08
New Moon	August 19 at 2:45
First Quarter	August 26 at 9:49
Full Moon	September 3 at 12:28
Apogee: August 1 at 10h	405,448 km
Perigee: August 17 at 2h	362,540 km
Apogee: August 29 at 0h	404,650 km

universal time

Astronomers the world over use an unambiguous system of time reckoning — Universal Time (UT) — based on a 24 hour clock. Times given in The Backyard Astronomer are UT unless noted otherwise. To convert UT into your local daylight time, subtract the following number of hours for each time zone: EDT, 4; CDT, 5; MDT, 6; PDT, 7; Alaska, 9. For example, if an event is to happen at 03:00 hours UT on June 7, then EDT for the event is 11 p.m., June 6. Likewise, 03:00 UT on September 2 becomes, in PDT, 8 p.m., September 1.

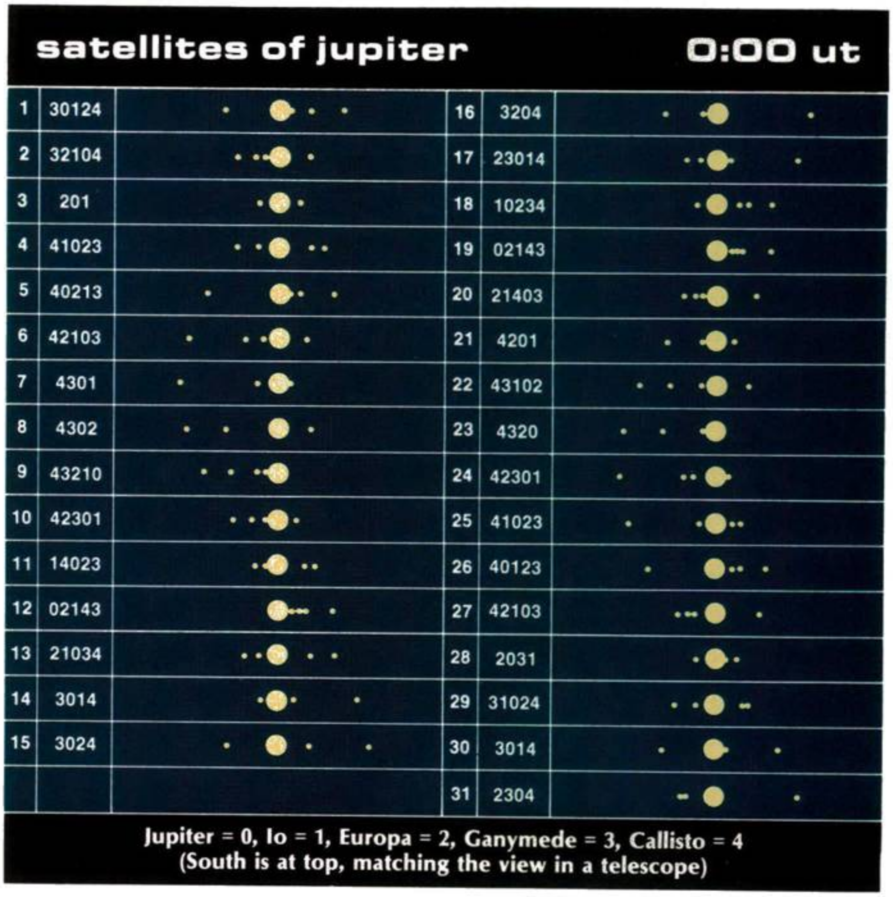
Planetary photographs are a challenge because you need long focal lengths and excellent seeing conditions. For this superb Jupiter photo, Jean Dragesco used a 14-inch Schmidt-Cassegrain and a 6-second exposure on ASA 200 film. The cloud belts in both hemispheres, the Great Red Spot, and a transit of Europa (dark spot on bottom) show up clearly.

magnitude 58 Ophiuchi, the best star to use, isn't hard to pick out. It lies just 8° to the northwest of the spout of Sagittarius' Teapot and is the brightest star in the region. When you center 58 Oph in your low-power eyepiece, sweep about 20′ of arc south and then 5 or 6 minutes of R.A. west. You'll recognize Neptune by its tiny grey-green disk, 2.5″ of arc across and at 7.7 magnitude. Use at least 100x.

Meteors

The famous Perseid shower in early August gives you an excellent opportunity to begin or renew your acquaintance with meteors. With the shower reaching peak activity around the 12th — when many vacationers are away from cities and their annoying lights — you should be able to enjoy this popular and plentiful annual shower.

Unfortunately, this year's display will be marred: Its peak activity comes during daylight for North America,



satellites of jupiter 0:00 ut

1	30124
2	32104
3	201
4	41023
5	40213
6	42103
7	4301
8	4302
9	43210
10	42301
11	14023
12	02143
13	21034
14	3014
15	3024
16	3204
17	23014
18	10234
19	02143
20	21403
21	4201
22	43102
23	4320
24	42301
25	41023
26	40123
27	42103
28	2031
29	31024
30	3014
31	2304

Jupiter = 0, Io = 1, Europa = 2, Ganymede = 3, Callisto = 4
(South is at top, matching the view in a telescope)

Left: for this photo of M-22, a globular near the Teapot, Jack Newton used a 16-inch scope and a 15-minute exposure on ASA 200 film. John Kerns caught this -3 magnitude Perseid (right) on ASA 400 with a 10-minute unguided exposure and a 50mm lens. The Last Quarter Moon will drown out faint Perseids during the shower's August 12 peak.

and the Moon will be at Last Quarter on the same day. Its light will flood the sky and obliterate the fainter Perseids.

But make the best of it and catch what meteors you can — after all, this shower lasts several weeks. Observe before the peak on the night of August 11/12 and on the night after the peak. Take out a lawn-chair, some blankets or a sleeping bag, and bug repellent. Face the northeast, get comfortable, and look for streaks of meteors coming from the sky between Perseus and Cassiopeia. During a Moonless "Perseid night," you could see 25 to 50 meteors per hour after midnight (1 a.m. daylight time), but the Moon this year will cut that rate in half.

close-up on cygnus

High overhead on late summer nights stands the sprawling Northern Cross embedded among the rich Milky Way glow. Centuries have not disturbed its shape, and it is as beautiful now as it was to Chinese astronomers 2,500 years ago. Sweeping this region with low power is akin to counting grains of sand on a beach. All manner of deep sky objects float into view, but the most intriguing sight is the wealth of detail this constellation holds.

Because of its elevation, **Cygnus** rivals Sagittarius in beauty for northern hemisphere viewers. If this constellation rode the horizon, much of its splendor would have escaped the ancient's reverent gaze.

Barns opened his introduction to Cygnus with this: "The graceful star imagery of the Swan, with its six high magnitude brilliants slanting a cross athwart the northern heavens, is the very ganglion of the Galaxy, making the search for reputed features rather difficult, since on every hand there is such a bewilderment of stellar riches."

Webb noted that Cygnus was "a fine cruciform constellation. I had at one time projected a survey of the wonders in this region with a sweeping power; but a want of leisure, an unsuitable mounting, and the astonishing profusion of magnificence combined to render the task hopeless for me, which I trust, may be carried out by some future observer." Even Webb gave up at cataloging this region and satisfied himself with simply looking.

Alpha (α) Cygni, or **Deneb**, is the 19th brightest star in the heavens — a 1.3 magnitude blue-white supergiant of spectral class A2. It marks the top of the Cross. If Deneb were closer, it would be incredibly brilliant — it outshines the Sun 60,000 times!

From the Cross's apex, drop all the way through the Milky Way to the bottom point, and you'll find Beta (β) Cygni, or **Alberio**, the most famous double in the sky. Observers generally agree that Alberio is a showpiece with its contrasting colors and bright visual magnitude. Descriptions of this pair abound in literature. Brown stated, "you are not a stargazer if you haven't seen this popular double."

Alberio is actually three stars according to spectroscopic data, but only two are within reach of amateur equipment. In the eyepiece, you'll see a third magnitude orange star, type K3, and a fifth magnitude blue, type B8 companion 35 seconds of arc apart near position angle 55 degrees. The field itself is rich with a generous sprinkling of stars — brilliant and best in small apertures.

61 Cygni, another double in our survey, is particularly suited to small instruments and historically important. The visual observer will see two orange stars of near equal brilliance. These components are magnitude 5.3 and 5.9 and type K5 and K7. Draw a line from Deneb through Nu (ν) Cygni and you'll spot 61 Cygni as the westernmost star of a small trio. A 2.4-inch at 30 power gives a good view of these two suns.

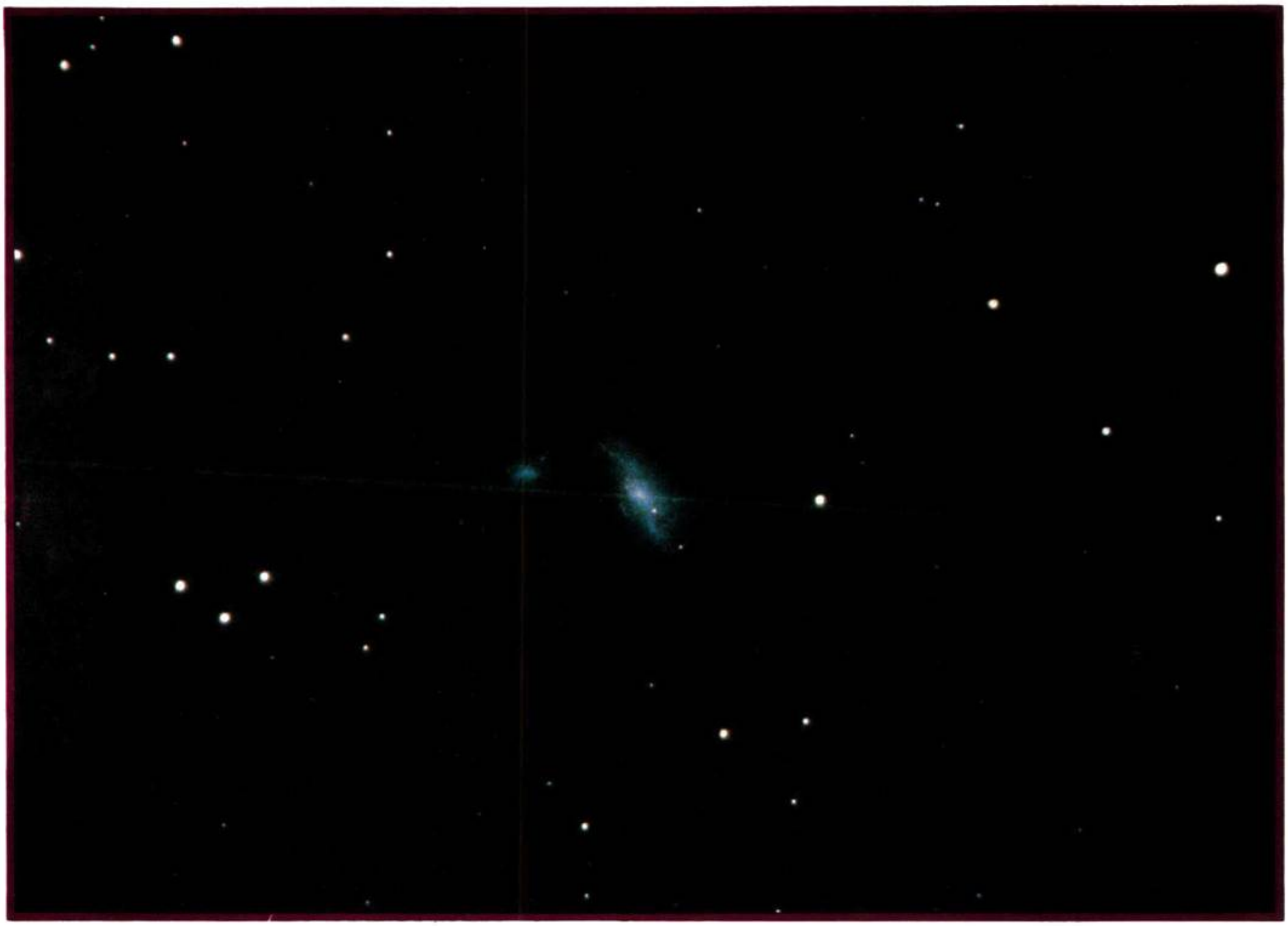
61 Cygni is only 11.2 light-years away. Early astronomers noticed a large proper motion in this system possibly indicating an unseen companion. Astronomers determined in 1942 the dark body is eight times as massive as Jupiter and revolves around the A star every 4.8 years.

One of the strangest objects in the sky is **Cygnus X-1**, the first stellar X-ray source recorded. The main star lies 0.5° east-northeast from Eta (η) Cygni and is easy to spot in small telescopes. The star is a very hot and luminous supergiant of spectral type B0 Ib with a surface temperature of 30,000°K. Studies done in 1973 indicate that a strongly heated stream of gas passes from the B component to an unseen companion; incredible X-ray emissions originate from this area as the hot gases plummet into an invisible something — a black hole?

Astronomers believe the invisible companion is a fully collapsed body with a mass in the range of 15 to 20 Suns — but only 100 miles in diameter. We can detect it only indirectly, and calculations indicate that it is too small for a neutron star or a white dwarf. Astronomers think it must be a black hole.

Returning to more normal deep-sky objects in Cygnus, we find two clusters discovered by Messier. First is **M-29**, two degrees south and slightly east of Gamma (γ) Cygni. You can see it in your finder as a hazy patch, but through the scope it shines at 7th magnitude and contains a dozen or more stars in a trapezoidal shape.

In a 6-inch at 50 power M-29 is a good sight, but not as rich as many other clusters. Against the dense background of the Milky Way, it loses some of its charm. Holyoke said, "It is quite difficult to pick out of its surroundings, and the larger the



If you spend enough hours observing, you'll eventually see something you think shouldn't be there. Jack Newton photographed NGC-4490 at 10 p.m. on April 24 and noticed a bright star he didn't recognize near the galaxy. When he checked with professional astronomers, they told him he had photographed a 14.6 magnitude supernova another observer had recently discovered.

telescope, the more difficult it becomes. Its beauty lies in the region it occupies which is unsurpassed anywhere in the sky." Its position in a dense, dust-filled section of sky accounts for its lack of luster.

Messier's second cluster, **M-39**, is a better sight. It is a large but very loosely structured open cluster located 9° east-northeast of Deneb. M-39 is easy to find in binoculars, but too wide for long focus telescopes; it's best in an RFT. The cluster's twelve brightest stars are type A or B and are scattered over a field the size of the Full Moon. Virtually all of M-39's members are main sequence suns. Imagine the glittering night sky of a planet in this cluster.

For a change from stellar offerings turn to **NGC-6960** and **NGC-6992**, two filamentary gaseous nebulae that form the Bridal Veil Nebula. NGC-6992 looks like a miniature Milky Way in the field of an RFT at low power. You'll need a very clear and transparent night and fully dark adapted eyes to glimpse the lacey cloud. This entire region is convoluted with chain after chain of similar nebulosity probably connected in some way. Kelvin McKready in his *Beginner's Star Book* described these nebulae as "the long and shelving undulations of a thin cataract of light, as it slips from star to star in its shining fall through space."

The clouds are about 1500 light-years away and 70 light-years in diameter. Their outward expansion is slowed by the dense dust in this region, but the cloud itself acts like a broom as it sweeps up everything in front of it. You can check this by looking at long-exposure photos. More stars are visible inside the veil than out, since the cloud has swept obscuring dust out of the way.

Another wide nebula in Cygnus is the famous **North America Nebula**, a vast cloud of mixed nebulosity, dust and stars. It is one of the outstanding objects in the northern Milky Way. Binoculars show an amorphous glow more than 1½° in diameter and 3° east of Deneb. On dark nights you can glimpse the prominent shape. It is in a remarkable field generously sprinkled with all kinds of stars. Wide-angle optics give the best view of this part of the Cygnus nebulosity.

Our last trio of objects centers around the star Gamma (γ) Cygni. Here we find **NGC-6888**, **NGC-6866**, and **NGC-6819**, all within 7° of Gamma.

NGC-6888, the Crescent Nebula, looks like a miniature version of the Veil. It is small and like many objects in the region lies in a field rich with background stars. Dark skies and good seeing are prerequisites to finding this cloud, but the time you spend scanning will bring even more sights into view.

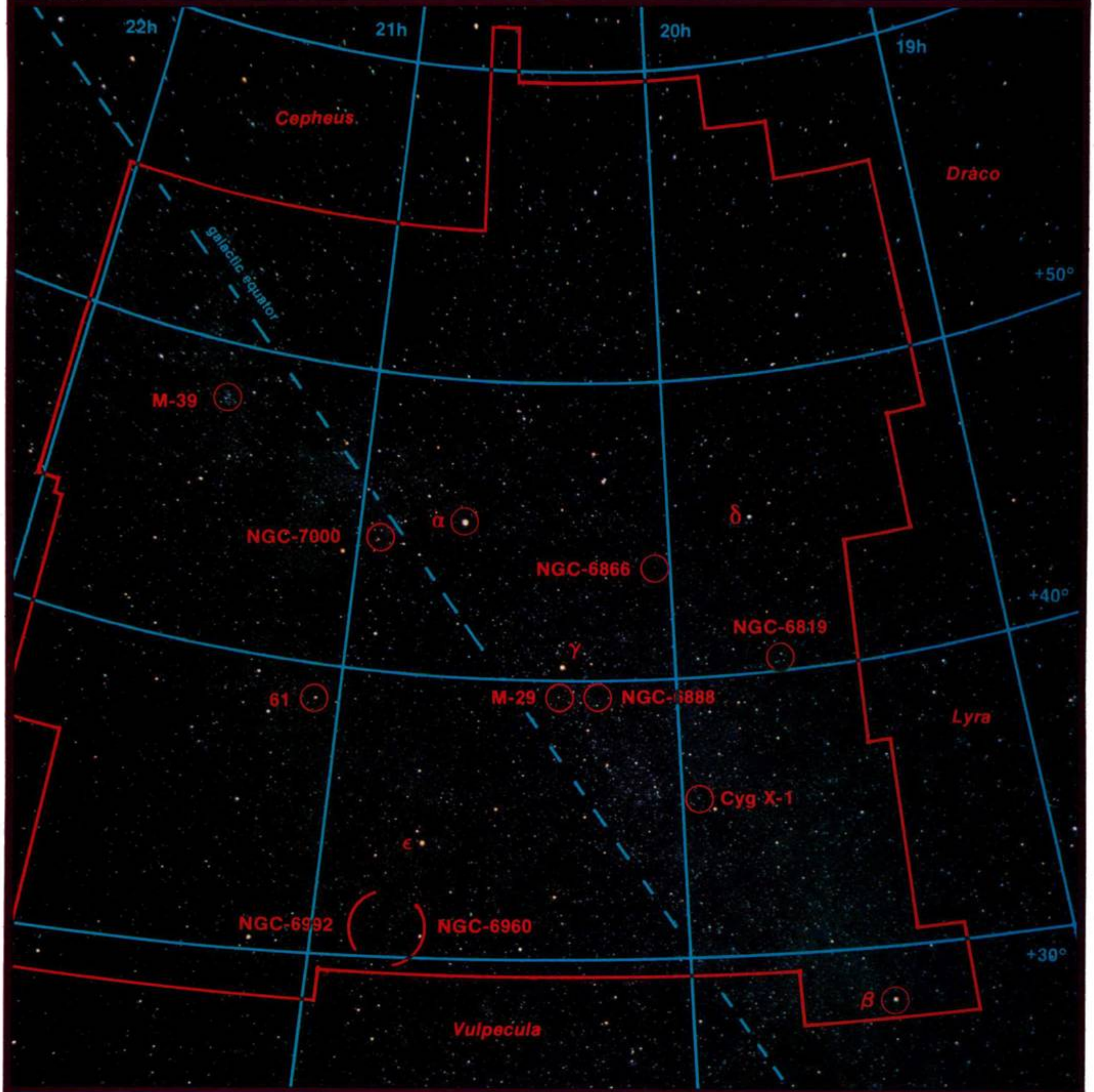
NGC-6866 is located 4.7° from Gamma and is a tight compact cluster of about two dozen stars. This object is nice in 6 or 8-inch scopes at 60 power. It will just about fill the field with a generous sprinkling of eighth magnitude suns.

Last on our list of selected objects is NGC-6819, seven degrees west of Gamma. This cluster is framed by much brighter stars. Look for a small patch of 150 stars near 10th magnitude. This deep-sky object is a treat through large aperture instruments since you can use medium or higher powers to resolve the faint members. All of these objects make fine prime-focus portraits with fast Newtonians. Our files don't include many of these lesser observed NGC-objects, so if you take some photos, send them along.

cygnus

Photo by Robert Provin and Brad Wallis

Map by Robert Burnham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21h
20h
19h
Cepheus
Draco
galactic equator
+50°
M-39
NGC-7000
α
δ
NGC-6866
+40°
NGC-6819
γ
61
M-29
NGC-6888
Lyra
Cyg X-1
ε
NGC-6992
NGC-6960
+30°
β
Vulpecula

Object	Type	Mag.	Size/Sep. Per.	R.A. (1950)	Dec.	R.A. (2000)	Dec.
Beta (β) Albireo	★^{2}	3.1, 5.1	34.3″	19h29m	+27°51′	19h31m	+27°58′
Cyg X-1	radio	9.0	—	19h57m	+35°04′	19h58m	+35°12′
NGC-6819	○	10	6′	19h40m	+40°06′	19h41m	+40°13′
NGC-6866	○	8	8′	20h02m	+43°51′	20h04m	+44°00′
NGC-6888	□	9.0	18′ 12′	20h11m	+38°16′	20h13m	+38°25′
M-29	○	7.0	6′	20h22m	+38°21′	20h24m	+38°31′
Alpha (α) Deneb	★	0.0	—	20h40m	+45°06′	20h41m	+45°17′
NGC-6960	□	—	70′x6′	20h44m	+30°32′	20h46m	+30°43′
NGC-6992	□	—	78′x8′	20h54m	+31°30′	20h56m	+31°42′
NGC-7000	□	—	100′ 120′	20h57m	+44°08′	20h59m	+44°20′
61	★^{2}	5.2,6.0	25″	21h05m	+38°33′	21h07m	+38°45′
M-39	○	5.0	30′	21h30m	+48°13′	21h32m	+48°26′

★	*Star*
★^{2}	*Double Star*
★^{3}	*Triple Star*
m★	*Regular Variable*
∩★	*Irregular Variable*
H★	*Eclipsing Variable*
○	*Open Cluster*
●	*Globular Cluster*
■	*Planetary Nebula*
□	*Bright Diffuse Nebula*
§0	*Elliptical Galaxy*
§S	*Spiral Galaxy*
§ʃ	*Barred Spiral Galaxy*
§#	*Peculiar/Irregular Galaxy*

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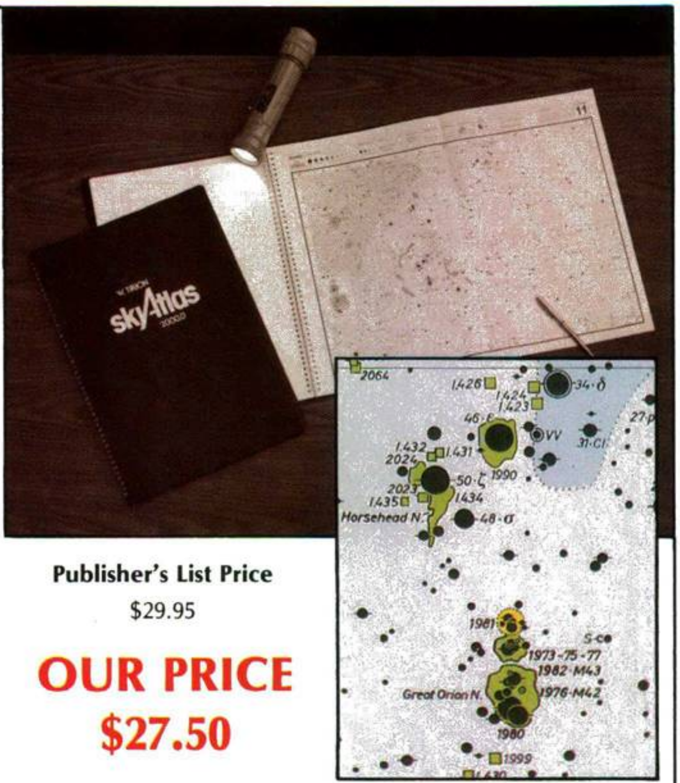
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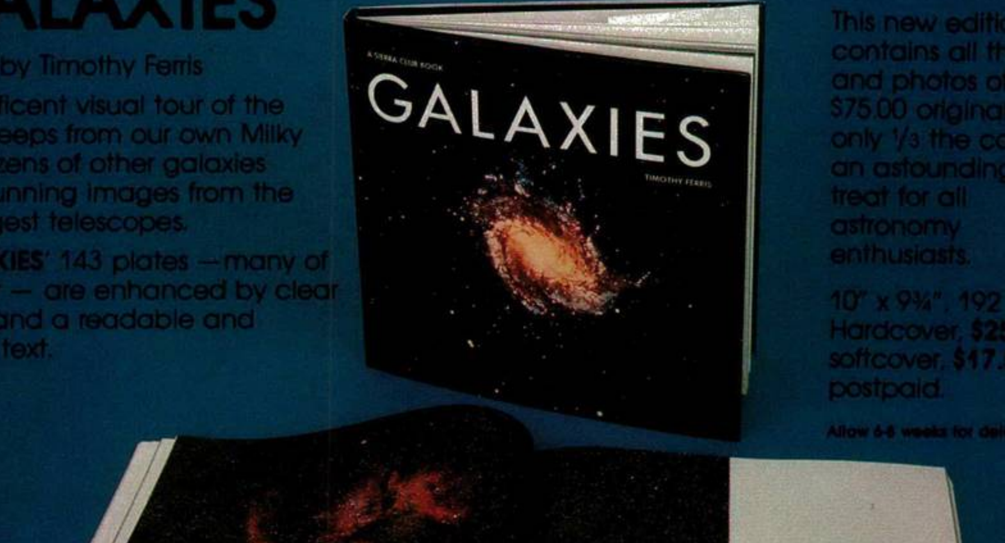
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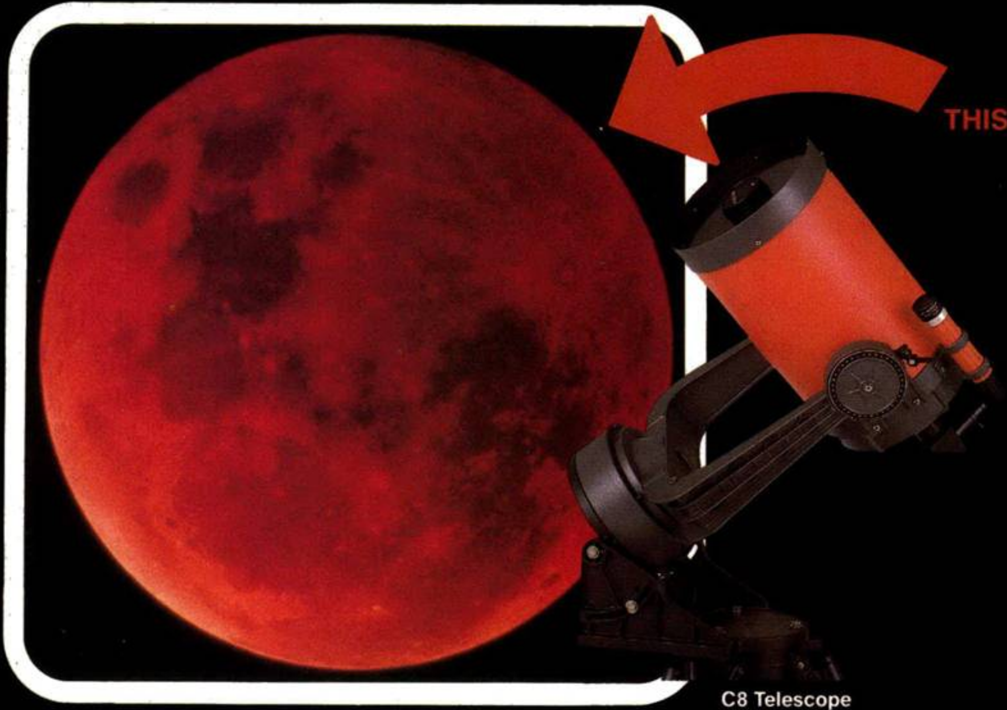
CELESTRON® TECHNICAL COMMUNICATION **4**

WHAT'S NECESSARY FOR DEEP-SKY ASTROPHOTOGRAPHY?


C8 Telescope

THIS STAR IMAGE TELLS YOU A LOT!

This star image was recorded during a 30 second unguided exposure by Tom Johnson that was made to capture this lunar eclipse. We show this to demonstrate the Celestron's drive stability. Look also at the other photographs on this page and the back cover of this magazine. all astrophotographs were taken by stock C8's.

EQUIPMENT FOR GUIDED ASTROPHOTOGRAPHY

Interest in astrophotography has grown immensely in the last decade. Beautiful photographs taken by amateur astronomers adorn the popular journals and raise the ambitions of many beginners. Celestron encourages your efforts but we do not wish to imply that deep-sky astrophotography of galaxies, nebulae, etc., is effortless. Photography of terrestrial subjects, the Moon and the planets can be easily done with little more than your camera and a few adapters; exposure times are short (see our new accessory catalog for a table of exposure times).

Deep-sky photography requires long exposures, thus you guide the telescope—mechanically adjust the position of the telescope during the exposure. There is no drive system on Earth that is 100% free of mechanical error. If you simply attached your camera to the back of any telescope, and took a one-hour exposure, the stars' images would be trailed on the film. You can buy very expensive telescope mounts and drive systems that allow short unguided exposures with short focal length telescopes; but, for long exposures at long focal lengths you still must guide your telescope.

To guide your telescope during a long exposure you need two accessories. First, you need a way to tell if the telescope is not tracking, or following, an object precisely. This is a "guiding system". Celestron offers both guide telescopes and off-axis guiding systems for this purpose. The guide telescope is a separate telescope on top of the photographic telescope (such as a C90 on a C8), you follow your target by watching through the guide telescope. A better way to guide is Celestron's off-axis guiding system. In the off-axis guiding system you guide by watching a star at the edge of the field of view of the photographic telescope; a small prism diverts the image to a guiding eyepiece—an eyepiece with a cross hair for position reference.

The second piece of hardware necessary for deep-sky photography is a drive corrector. A guiding system, discussed above, tells you that you are moving off target. A drive corrector is an electronic device that slowly moves the telescope back on target; the drive corrector actually does the positional correction that the guiding system detects. During a long exposure you must constantly monitor the tracking of your telescope.

Summary: What's needed for long exposure deep-sky astrophotography on a C8?

1) Guide system—Celestron recommends the Off-Axis Guiding System (consisting of the Off-Axis Guiding Body and an Illuminated Reticle Ocular).

2) Drive Corrector (both single axis–E/W–what's absolutely necessary–and dual-axis N/S and E/W are available).

3) Your camera and cable release.

4) Counterweights.

5) Tele-Compressor (shorten exposure time by reducing the focal length and f/ratio).

You always must guide when photographing through a long focal length telescope during a long exposure, no matter what type of drive system is employed. Expensive drives and mounts mean fewer corrections during the exposure, but good systems are very expensive. Celestron offers you telescopes and accessories that are capable of deep-sky photography as well as visual observing.

We show three photographs taken on stock C8's. M51 was a one-hour exposure with a Celestron Cold Camera (Ektachrome 400), M8 with hypersensitized film and a tele-compressor and M33 is a one-hour exposure on Ektachrome 400 with a Celestron Cold Camera.

M51–C8–COLD CAMERA–BY JOHN GLEASON

M8–C8–HYPERSENSITIZED FILM–BY PAUL BURKE

M33–C8–COLD CAMERA–BY JOHN GLEASON

SEE BACK PAGE FOR CATALOG INFORMATION

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We offer as proof of the C8's drive stability this photograph of the Orion Nebula, M42. This is a 60-minute exposure on Ektachrome 200 taken with a Celestron Cold Camera and a stock Celestron C8; photo by John Gleason. It is the skill of the user that ultimately allows such fine results. Celestron offers you the stock telescope and accessories for your own adventure into astronomy.

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The C8
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CATALOG

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